DISTRIBUTION, RANGE USE AND MOVEMENTS OF ELK ON THE SHILO MILITARY RESERVE

By

John Thomas Strong

A Practicum Submitted
In Partial Fulfillment of the
Requirements for the Degree,
Master of Natural Resources Management

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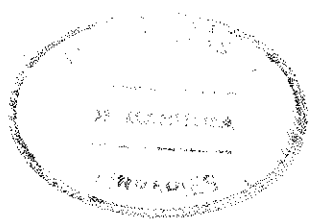

ABSTRACT

The apparent increase in elk (*Cervus elaphus manitobensis*) numbers on the Shilo Military Reserve increased speculation as to the effects of military activity on resident elk. The Reserve, encompassing 60,000 ha and located 160 km west of Winnipeg, is bounded by agricultural land and a provincial park.

Distribution, range use and movements were determined by relocating radio-collared elk and by observing non-collared elk.

Male and female elk were differentially distributed. Bulls preferred the northeastern portion of the Reserve. Most elk used the same range throughout the study and showed little seasonal preference. Movements of male elk were more extensive than those of females. Movement to new ranges was noted in young elk (both male and female).

Military activity is not a major influence on elk movement or distribution except in a local sense. Fire, largely caused by military activity, creates elk habitat and affects seasonal movement and distribution.

ACKNOWLEDGEMENTS

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INTRODUCTION

1.1 PROBLEM STATEMENT

The effect of harassment and disturbance on elk has been discussed by many researchers. Hayden-Wing (1979) stated that human activity caused elk (*Cervus elaphus nelsoni*) to "compress" in remote portions of their range in southeastern Idaho. Human disturbance has been indicated as a possible factor influencing elk winter range in Alberta (Telfer 1978). Harassment of elk resulting from human use of elk range was noted in Pennsylvania (Eveland *et al.* 1979) and in Alberta (Morgantini and Hudson 1979). Reaction to human disturbance may be less pronounced in Spruce Woods elk. Hornbeck (1979) found that elk remained for extended periods on the periphery of relatively high-use recreation areas. Elk in Prairie Creek Redwoods State Park, California also exhibited a tolerance for people (Franklin and Lieb 1979).

Seasonal use of different segments of available range by elk is characteristic. This trait has been reported from Montana (Knight 1970, Mackie 1970, Craighead *et al.* 1973), Idaho (Hayden-Wing 1979), Pennsylvania (Eveland *et al.* 1979), California (Franklin and Lieb 1979), Alberta (Telfer 1978) and Manitoba (Green 1933, Hornbeck 1979). Hornbeck (1979) found that in the Spruce Woods the majority of elk frequented the Reserve as opposed to the Park. There is, however, some difference of opinion on the factors which influence distribution.

Hayden-Wing (1979) stated that elk distribution appeared to be influenced primarily by human activity and secondarily by snow depth and vigor of browse. Gaffney (1941) cites snow depth and condition as major factors in elk use of winter range. Telfer (1978) surmised that elk winter utilization of an area was not strongly related to browse availability but may be related more to traditional wintering areas and disturbance.

Since 1974, armed forces of the Federal Republic of Germany (hereinafter called West Germany) and Canada have conducted intensive ground training exercises at C.F.B. Shilo (Fig. 1). Use of the military reserve has increased over the years to include infantry, tank, Marder, artillery and other training exercises. Zones 8 and H in the northeastern portion of the Reserve have remained relatively unused due to lack of access across Epinette Creek and the associated swamp (Fig. 2).

The elk (*Cervus elaphus manitobensis*) population in the Spruce Woods-Shilo region has been increasing over the years (Hornbeck 1979). Concern was expressed that the unused portions of the Reserve were important as "sanctuaries" for elk from at least certain types of military training. The C.F.B. Shilo base commander was advised by the Shilo Environmental Advisory Committee that a detailed study of elk use of the northeastern portion of the Reserve was required prior to any development of the area for military purposes. Analysis of data regarding elk movements, habitat use and response to disturbance in the military reserve was required for the management of the elk population.

The Spruce Woods Provincial Park and surrounding area is becoming an all-season, multiple-use recreation area. The elk population might

Figure 1. Location of study area.

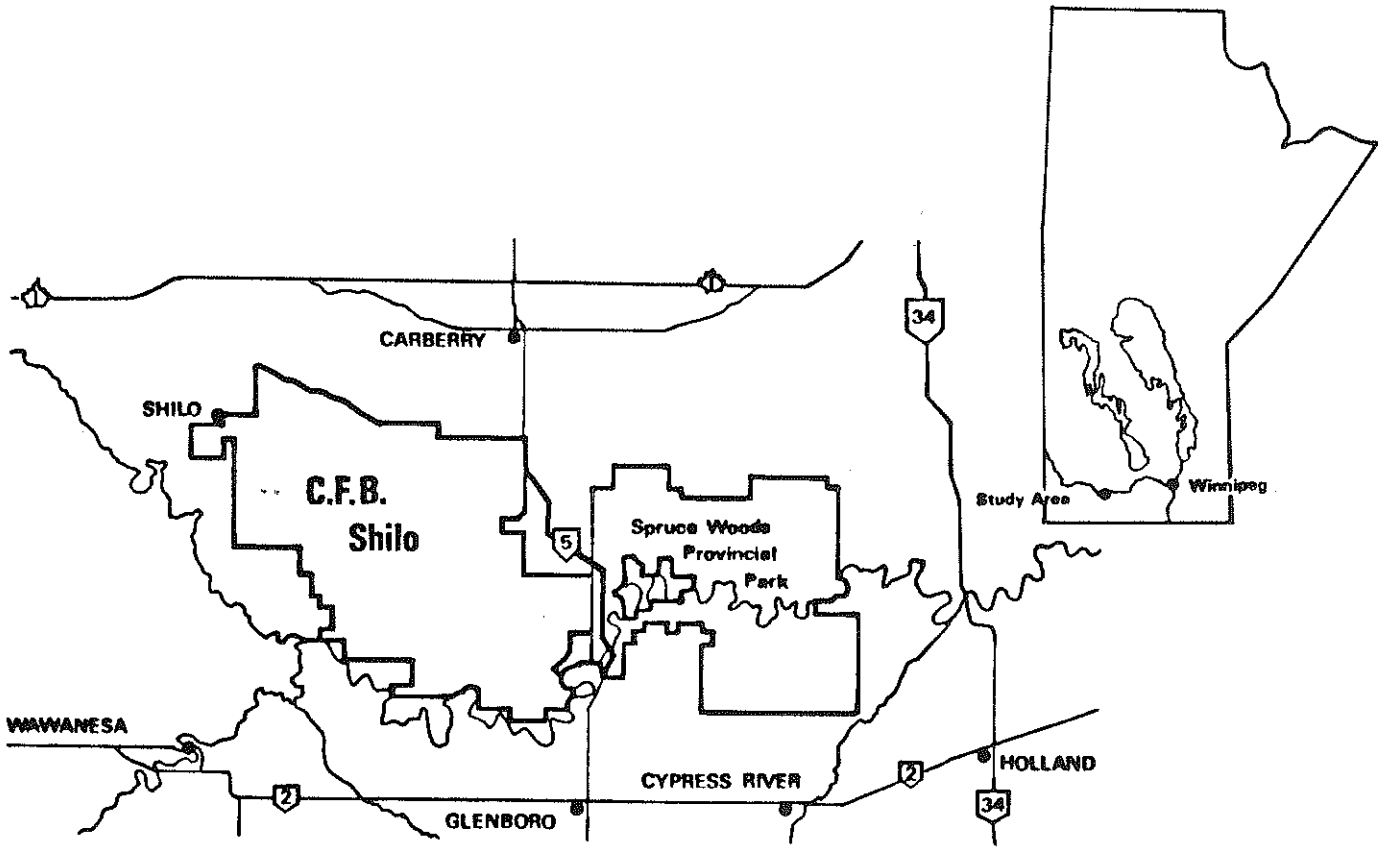
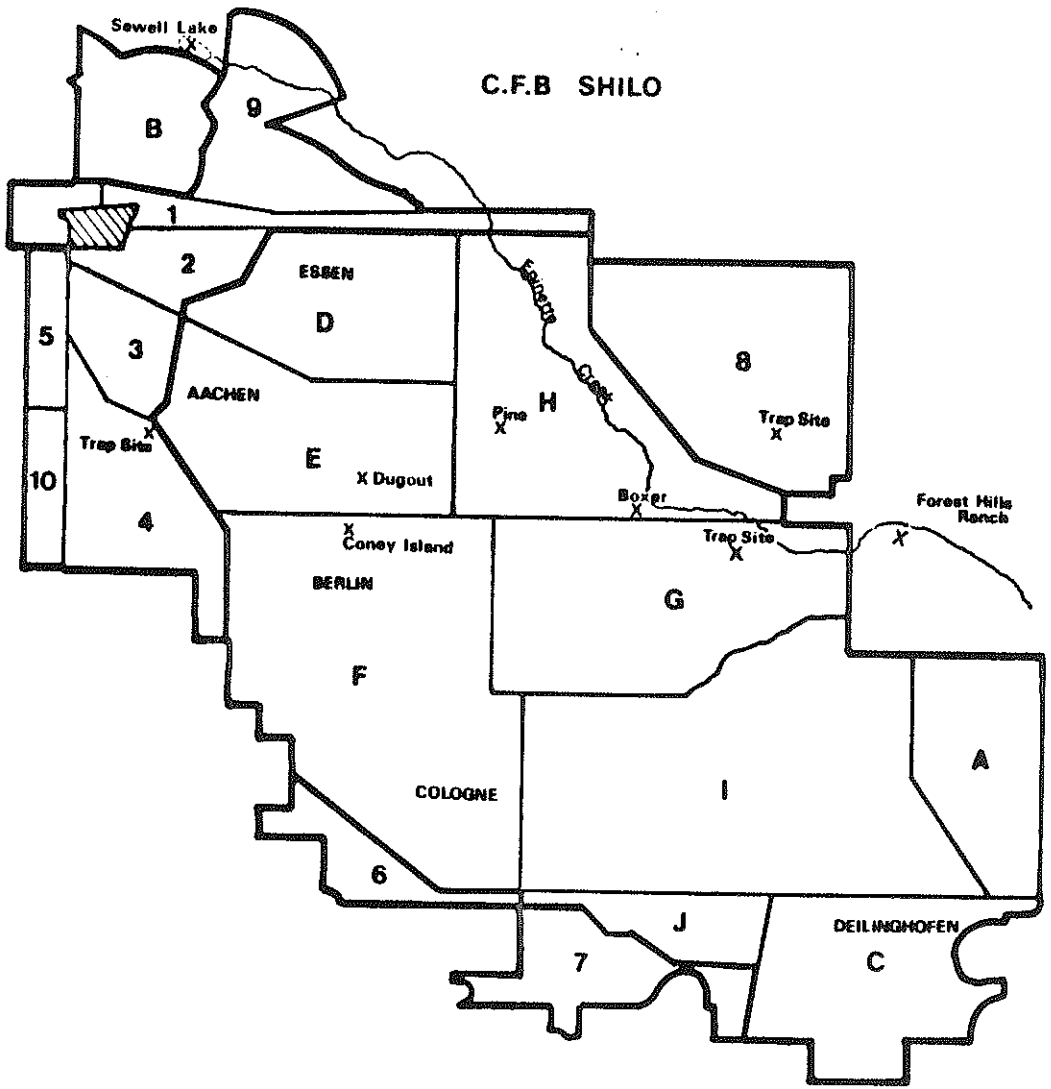

CARBERRY
SHILO
C.F.B.
Shilo
Spruce Woods
Provincial
Park
WAWANESA
GLENBORO
CYPRESS RIVER
HOLLAND
Study Area
Winnipeg
1
5
2
34

Figure 2. Zonation and major landmarks of the study area.


C.F.B SHILO
Sewell Lake
B
9
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AACHEN
Trap Site
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Coney Island
BERLIN
F
COLOGNE
6
Eagle
Creek
H
Pine
8
Trap Site
Boxer
Trap Site
Forest Hills
Ranch
G
I
A
J
7
DEILINGHOFEN
C

provide both consumptive and non-consumptive recreation. Provincial wildlife authorities had considered a hunting season on elk in the Spruce Woods. This plan was implemented on an experimental basis in 1979.

1.2 OBJECTIVES

The objectives of this study are:

(1) To determine the importance of military Zones 8 and H to elk in terms of their habitat requirements and military activity.

(2) To determine the impact of military training on the habitat and behaviour of elk on the Shilo Military Reserve.

(3) To assess the potential recreational uses of elk in the Spruce Woods region.

1.3 GLOSSARY OF TERMS

Activity Centre: those ecologic areas most intensively used by an animal (Craighead *et al.* 1973).

Battle Run: a designated portion of the Shilo Military Reserve used for training exercises involving mobile weaponry. There are five such runs on the Reserve: Essen, Aachen, Berlin, Cologne and Deilinghofen.

Elk: *Cervus elaphus manitobensis* (Millais). Also known as wapiti.

Firing Point: the location of a weapon firing live ammunition.

Group: a small aggregation, generally less than 50 elk.

Habitat: the place where a population lives and its surroundings, both living and non-living (Smith 1966).

Harem: a group of female animals defended by a male during the

breeding period (after Dasmann 1966). Immature females and males may be associated with the breeding group.

Herd: an aggregation of elk sharing a specific and generally discrete home range.

Home Range: an area in which an animal spends all or most of its time (Dasmann 1966).

Impact Area: a portion of the Reserve where the impacts of explosive devices occur.

Park: Spruce Woods Provincial Park.

Population: total elk resident in the Spruce Woods region.

Reserve: Shilo Military Reserve.

Rut: the breeding season which takes place in the fall.

Seasonal Range: spring = March 21 to June 21, summer = June 22 to August 31, fall = September 1 to December 2, winter = December 3 to March 20.

Tank Track: a specific route used by tanks when moving from point to point.

Zone: a unit of land with definite boundaries designated by the military for training purposes.

1.4 LIMITATIONS

(1) The Shilo Military Reserve is used for military training involving the use of live ammunition. Access to the Reserve is restricted and continued relocation of instrumented animals is not possible. Access is possible only within the constraints imposed by military activity.

(2) Military training involves considerable use of radio communication. This fact, coupled with the increasing use of radio communication by the general public, created radio interference which, at times, prevented elk relocation by masking signals.

(3) The topography and forest cover of the Reserve created signal bounce and reduced the effective range of the transmitters placed on the elk.

1.5 HYPOTHESES

This study will address the following hypotheses:

(1) Epinette Creek is favoured for calving.

(2) Zones 8 and H are used by elk as seasonal range.

(3) Zones 8 and H are more useful to the male segment of the elk population.

(4) The Spruce Woods elk population can coexist with military activity and not be forced off the Reserve.

1.6 HISTORICAL ABUNDANCE OF SPRUCE WOODS ELK

Apparently elk were abundant from the Red River and Pembina Hills westward prior to 1884 (Soper 1961), although Bailey (1926) reports the last recorded elk kill in the Turtle Mountains in 1882. Seton (1909) referred to an elk killed in the Carberry Sand Hills during 1857 and states that, although many cast antlers were present in 1884, he saw only one elk in the area. The decline of the Spruce Woods elk population is mentioned by Criddle (1929) who wrote that in 1887 elk disappeared from the Carberry area, having been "tolerably" common

until that time. The decline of the elk population seems to coincide with the peak of the settlement period in 1881 (Dubois 1976). However, there may still have been elk in southern Manitoba. The Banff herd of 32 elk originated with four males and one female purchased from a Mrs. Ticknor of Morden, Manitoba and one female purchased from a Mr. Marlatt of Portage la Prairie, Manitoba in 1900 and 1902, respectively (Lloyd 1927). The elk referred to were no doubt captive animals, but unfortunately no mention is made of the period of captivity or locale of capture.

In 1917 after the failure of homesteads in the sand hills, seven elk, consisting of six females and a young male, were introduced to the Spruce Woods from the Winnipeg Zoo in an attempt to restock the area (Manitoba Department of Agriculture and Immigration Annual Report 1917). Ten elk were seen in 1918 (Manitoba Department of Agriculture and Immigration Annual Report 1918), but only four the following year (Manitoba Department of Agriculture and Immigration Annual Report 1919).

There is no mention of Spruce Woods elk in the Government of Manitoba annual reports during the next 30 years, except for a statement in 1931 that there are no elk in the Spruce Woods area. It was a common belief that the elk were extirpated. It is unlikely that elk were present in any number during this period as there was considerable activity in the forest reserve.

In 1951 elk were again reported from the Spruce Woods. Nine were seen during a March aerial deer survey, and during a November survey a single bull was reported (Manitoba Government Annual Report 1951). In 1952 Stuart Criddle (unpublished data) reported an illegal elk kill near Treesbank. Wrigley (1974) states that aerial survey data made available

by Eugene Bossenmaier showed two elk in 1958 and no elk in 1959. Range control staff from C.F.B. Shilo saw groups of 15-20 elk frequently during the late 1950's, and on more than one occasion observed elk or deer that had been killed by artillery fire (Ed Harrington, Canadian Forces retired, pers. comm.).

The Spruce Woods elk population apparently increased during the 1960's, perhaps the result of a downward swing in military activity. Wrigley (1974), from Bossenmaier's data, indicated that there were 15 elk in 1960, 35 elk in 1961, 58 elk in 1962 and 63 elk in 1963. The Manitoba Department of Natural Resources Annual Report for 1962 states that "a small band of elk survives in the Spruce Woods forest reserve", but does not give any population figures. The Manitoba Department of Natural Resources Annual Report for 1963 reports the first crop damage by elk in the Spruce Woods. In 1967 the Manitoba Department of Natural Resources Annual Report stated that there were approximately 120 elk in the Spruce Woods herd. Hay damage by elk was noted near the north boundary of the Park. The 1968 Annual Report of the Manitoba Department of Natural Resources contained an estimate of the Spruce Woods elk population, 100-150, and stated that 30 elk were killed illegally during the deer season.

In 1968 Conservation Officer D. W. Campbell (unpublished data) stated that the elk appear to winter in the muskeg west of Forest Hills Ranch up to Sewell Lake, move south closer to the farming area in spring, to spend the summer, and then slowly return north and west to the muskeg in late fall. A map accompanying the Campbell report shows illegal kills between 18 and 30 November. Ten females and three males were killed illegally; the distribution of kill sites was widespread over

the ranges.

In 1969 Canada Land Inventory staff counted 145 elk in the Spruce Woods (Ransom 1969). Elk were reported damaging crops in the Portage la Prairie area; a bull elk was sighted at Turtle Mountain the same year (Manitoba Government Annual Report 1969). A dead bull elk from Spruce Woods was examined in February 1969, but the results of that examination were inconclusive. Death was attributed to possible malnutrition (Manitoba Government Annual Report 1969).

Military pilots flying over the Reserve commonly saw elk during the late 1960's and on occasion observed large groups (L. Geldart, military pilot, retired).

The widely held belief that the Spruce Woods elk immigrated from Riding Mountain National Park can be traced to the 1960's. Wrigley (1974) states, "about the year 1960, there was a reliable report of 13 elk moving from the Riding Mountains in the direction of the Spruce Woods forest." Bossenmaier (unpublished data) indicates that the Wildlife Branch, Government of Manitoba was aware of this movement. In a letter on file, he wrote, "we believe the present Spruce Woods herd originated from animals which moved naturally out of Riding Mountain."

Reinvasion is a possible explanation of the origin of the Spruce Woods elk. Blood (1966) summarized survey and harvest data for the Riding Mountain elk herd between 1943 and 1964. His summary indicates that high elk populations and severe winters, likely combinations for dispersal, occurred in 1949-50, 1950-51, 1955-56 and 1959-60. Green (1933) points out that historically the Riding Mountain elk moved off the highland to winter in the surrounding lowlands. Thus there is some historical basis for dispersal away from Riding Mountain. Observations

of elk moving south during these times may never have come to public attention. Elk that may have dispersed from Spruce Woods have been seen during recent years at Souris, Oak Lake, Turtle Mountain, Brandon and MacGregor. Elk for the last three locations were reported to be bulls.

It is also possible that remnants of the original elk population survived in the Spruce Woods. Reports to the contrary are few and are basically opinions of individuals. The differences between the official estimates of the numbers of elk in the Spruce Woods and observations of military personnel during the 1950's is perhaps an indication that few valid observations came to public attention. Military activity certainly restricted public access to the Reserve. A small moose population has apparently existed continually in the Epinette Creek area since historical times (L. Bidlake, pers. comm.) and, although habits and habitat requirements differ, the possibility of elk remaining undetected cannot be discounted. The present stock of Spruce Woods elk may result from a combination of remnant elk and newcomers from Riding Mountain.

The Spruce Woods elk received new attention in the 1970's. In 1970, 133 elk were counted during an aerial survey. The report stated that the herd had remained constant from many years (Manitoba Government Annual Report 1970). Recent study of the Spruce Woods elk began in 1977. The population has been counted annually since then. Hornbeck's (1979) estimates of 515 elk in 1977, 609 elk in 1978 and 919 elk in 1979 differ somewhat from the estimates of Manitoba Wildlife Branch staff who counted 568 elk in 1979 (L. Bidlake, unpublished data). Hornbeck (1979) may have used too large a percentage to compensate for areas not

covered. Aerial survey of the Reserve yielded 412 elk in January 1978 and also in 1979 (L. Bidlake, unpublished data). During a January 1980 aerial survey, 393 elk were seen on the Reserve and 540 elk on the Reserve and Park combined (L. Bidlake, unpublished data).

The population of Spruce Woods elk has apparently increased five-fold in the last ten years. During this period, observations of elk, both in the Spruce Woods and in more distant locales, have increased. During 1980, 12 bull elk were sighted north of Carberry and No. 1 highway and 9 elk were reported in the Brandon Hills (L. Bidlake, pers. comm.). In addition, seven elk were seen crossing a road in the Souris River Bend Wildlife Management Area (H. Goulden, pers. comm.). Elk depredation also has increased. Residents of the Spruce Woods have suffered extensive depredation on occasion and have, in some cases, changed the crop grown in certain locations in an attempt to reduce losses (C. Meyer, pers. comm.).

The Spruce Woods elk have been a source of aesthetic pleasure to local residents and have on occasion provided meat. Since the mid-1960's the elk have been a tourist attraction.

DESCRIPTION OF STUDY AREA

2.1 LOCATION AND LAND USE

The Shilo Military Reserve encompasses approximately 60,000 ha in southwestern Manitoba, 160 km west of Winnipeg (Figs. 1 and 2). It is bounded on the south by the Assiniboine River, Provincial Road 340 on the west, Provincial Highway 5 on the east and the Shilo-Brandon Junction branch of the Canadian National Railway on the north. The Spruce Woods Provincial Park is located southeast of the Reserve.

The area was homesteaded prior to 1885. It was poor farmland and reverted to the Crown in 1895 (Dubois 1976). Military activity in the area began in the years preceding World War I, but the present site was not used until 1934 and has only been used year-round since 1942. Training activities have included movement of tracked and wheeled vehicles, firing of high explosives and inert devices and infantry manoeuvres (G. Kerr, unpublished data). West Germany began training tank crews on the Reserve in 1974 under an agreement with Canada. Minor portions of the Reserve are used for battle runs and subject to intensive movement of heavy, tracked military equipment such as tanks.

Range fires resulting from the use of live ammunition occur frequently on the Reserve. A destructive fire occurred in 1961 when the eastern 2/3 of the range burned. Other major fires have occurred in 1968, 1972, 1974 and 1976 (G. Kerr, unpublished data). In 1977 some

4,000 ha burned (Hornbeck 1979). Fires during 1978 and 1979 burned 1,501 ha and 1,766 ha, respectively (Captain W. Gordon, pers. comm.). Nearly the entire Reserve burned during the extremely dry spring of 1980.

The bulk of the Reserve is essentially wild land, occasionally traversed by military traffic and by civilian traffic during the hunting season. Grazing and haying leases within the Reserve have generally been restricted to minor areas adjacent to the perimeter, but during the drought of the 1930's extensive grazing took place and cattle were brought in from as far away as Alberta (Dubois 1976).

In 1970 Spruce Woods Provincial Park was created to protect an area of provincial significance from degradation. The park area has a history of agriculture and was protected from fire. Hay and grazing leases are still issued in the Park. The Shilo Military Reserve and Spruce Woods Provincial Park are surrounded by a mixed farming community and much of the adjacent land is pasture.

2.2 VEGETATION

The floral composition of the region is characteristic of the meeting of three major biomes: boreal forest, aspen parkland and mixed grass-prairie. Bird (1930) lists the following biotic communities as occurring locally: sand plain, prairie, deciduous forest, mixed forest and larch swamp. The entire region is within the eastern aspen-oak and mixed woods portion of the aspen parkland (Bird 1961). Weir (1960) said that the Spruce Woods Forest was a relict forest which survived in the sand dunes due to special soil conditions when the rest of the

boreal forest retreated northward.

Vegetation is sparse in the active dune area and consists mainly of scattered clumps of grass. The stabilized dune area supports more vegetation which serves to hold the dunes in place and eventually transforms them into prairie. Plants characteristic of this biome are (Scoggan 1957): the grasses *Oryzopsis* spp., *Andropogon* spp. and *Calamovilfa longifolia*; a willow *Salix longifolia*; skeletonweed *Lygodesemia juncea* and dock *Rumex venosus*. In hollows where the water table is closer to the surface, the vegetation also includes horsetail *Equisetum* spp., bearberry *Arctostaphylos uva-ursi*, wolf willow *Eleagnus argentia*, chokecherry *Prunus virginiana* and groundsel *Senecio manitobensis*. Scoggan (1957) points out that the sand hills near Carberry and Glenboro are among the locations where remnants of the original prairie flora can be found.

The prairie community is a *Stipa-Andropogon* association which was the typical climax prairie of southwestern Manitoba and southeastern Saskatchewan, although other ground cover types may dominate specific areas particularly close to the margin of the prairie area. Extensive areas may be dominated by creeping juniper *Juniperus horizontalis*, bearberry, sand cherry *Prunus besseji* and various lichens.

The deciduous forest community is dominated by aspen *Populus tremuloides*, but bur oak *Quercus macrocarpa* is found in a few locales, and the flood plain of the Assiniboine River includes: American elm *Ulmus americana*, ash *Fraxinus pennsylvanica* and Manitoba maple *Acer negundo*. Typical understory shrubs are: Saskatoonberry *Amelanchier spicatum* and various cherries *Prunus* spp. and willows *Salix* spp.

The mixed forest is characteristic by an interspersion of aspen

and white spruce *Picea glauca* with the occasional bur oak. The smaller plants are similar to those found on the prairie and deciduous sites. This association is generally open with small prairie areas between stands of trees.

The larch swamp community is restricted to a few sites along the Assiniboine River and to the Epinette Creek area where extensive larch *Larix laricina* stands occur. Black spruce *Picea mariana* is associated with this community; the dominant shrub is the dwarf birch *Betula glandulosa*. Common ground cover species are: pitcher plant *Sarracenia purpurea*, sedge *Carex* spp., moss *Sphagnum* sp., reed-bentgrass *Calamagrostis* sp. and horsetail *Equisetum* spp., among others.

2.3 CLIMATE

The Spruce Woods region is in the transition zone between the moist and dry fringes of the dry subhumid regions of Canada (Weir 1960). The National Atlas of Canada (1971) indicates December to February temperatures between -25°C and -5°C and June to August temperatures between 5°C and 30°C. July is the warmest month of the year and January the coldest. Annual precipitation for the region is approximately 600 mm, with snowfall comprising 25%.

2.4 SOILS AND TOPOGRAPHY

The Spruce Woods region is within the black soil zone of the Chernozemic Order (Ehrlich *et al.* 1957). It is characterized by glacial sediments deposited in the delta of the Assiniboine River flowing into Lake Agassiz. The retreat of the lake exposed vast areas of sand which

have been modified by wind action into dunes. The present dunes are a unique feature in Manitoba.

Soils found in the region include the loamy sands of the Stockton Association with lesser amounts of Stockton fine, sandy loam, sand of the Miniota Association and the Marsh Complex soils of the Epinette Creek area (Ehrlich *et al.* 1957).

The underlying stabilized sand dunes give most of the area a rolling topography. The southeast portion of the Reserve contains an active dune area which terminates at the Assiniboine River escarpment and is known as the Bald Head Hills. The portion of the Reserve adjacent to the south and west margins of the Epinette Creek swamp consists of stabilized dune formations and contains the highest elevations in the Reserve as well as the most rugged topography.

The remaining portions of the Reserve become generally flattened at the Brandon Plain to the southwest.

METHODOLOGY

3.1 GENERAL STUDY DESIGN

The capture and instrumentation of elk provided information on movement and habitat usage as well as enabling the delineation of home and seasonal ranges. Radio relocations of elk were used in conjunction with factors such as vegetation, topography and military activity. Seasonal and home ranges were drawn on a minimum area basis as used by Craighead *et al.* (1973) with added corrections to compensate for location error and specific knowledge of the terrain. Radio relocations provided data that were of assistance in assessing all the hypotheses being tested.

Aerial surveys flown during the course of the study provided information on elk distribution, sex and age ratios and population trends. This information was used in assessing the first, second and fourth hypotheses.

Direct observation of elk was also used in testing the various hypotheses. Individuals observed within Zones 8 and H were recorded and applied to hypotheses one, two and three. Numbers of elk in this little-used corner of the Reserve were considered when testing hypothesis four, since it had been suggested as a possible refuge when artillery fire was taking place.

During the calving season all cows and calves seen were recorded.

The age of the calf was estimated to be greater than or less than two weeks since movement away from the parturition location is unlikely prior to this time (Johnson 1951, Altmann 1956). Calves judged to be less than two weeks old were assumed to have been born in the immediate locale.

Observations of elk were used to indicate reaction to disturbance. Direct disturbance by humans on foot or in wheeled or tracked vehicles, or indirect disturbance as a result of military activities, were noted whenever possible. Direct observation of the latter was possible on very few occasions. These data were used particularly in the assessment of hypothesis four. Careful attention was paid to flight distances, obvious alteration in behaviour from previous observations without influence and the presence or absence of what is conceived as "normal" elk behaviour in the literature. Elk were observed on some occasions by a hidden observer and on others by a visible observer. The visible observer, on occasion, deliberately drove a vehicle at faster than normal speed in the vicinity of elk, or approached on foot to observe the reaction.

Some elk locations were obtained from military personnel and area residents. Sex of observed elk was noted where it was obvious.

Track counts were carried out on the perimeter of Zones 8 and H, where ground conditions were suitable, to determine ingress and egress of elk. These counts were done weekly except during July. Track counts were also carried out in the vicinity of the dugouts in an attempt to compare an area known to be in constant use with Zones 8 and H.

Radio relocations and field observations during the period of September 1, 1980 to October 31, 1980 were collected by Ken Rebizant.

3.2 CAPTURE AND INSTRUMENTATION

Elk were captured in portable corral traps with self-tripping gates. Most elk were sedated by dart gun or jab-pole to reduce trauma and the possibility of capture myopathy, as well as to make collar and ear tag placement easier.

Elk were fitted with solar-powered transmitters, mounted on nylon web collars as obtained from Telemetry Systems Inc., Mequon, Wisconsin. The collars were attached with pop rivets and were colour-coded with vinyl tape to enable visual recognition of individual animals.

The transmitters operated in the 150-151 MHZ range; each unit weighed approximately 800 g. Power for the transmitter was supplied by two 1.5 volt nickel cadmium batteries which were charged by the solar panels. Theoretical life of the transmitter is five years with a signal receivable up to 12-15 km under ideal conditions. Each transmitter provided a signal on a specific frequency and had an identifiable pulse rate. In addition several of the collars had a variable pulse rate, the rate increasing with an increase in activity by the animal. One contained a mortality package that provided a steady signal after a 48-hour period of inactivity of the elk.

The instrumented elk were ear-tagged with a Ketchum coloured and numbered tag in each ear.

3.3 RADIO RELOCATION

Radio telemetry or radio location is a technique for extending the range of a person's observational powers (Craighead and Craighead 1965). The most primitive tracking system is capable of yielding a

considerable volume of location data (Brander and Cochran 1969), much of which would be otherwise difficult to obtain. The potential for gathering data may exceed the operational capacity of the investigator (Craighead *et al.* 1973). The technique allows the collection of time-specific locations with no observer disturbance and also allows several animals to be located within a minimal time span. The ability to locate animals in this manner can provide data regarding movement and habitat utilization during 24-hour periods, under varying conditions and during different seasons with relatively little change of observer-influenced behaviour.

The technique of pinpointing the location of an instrumented animal by fix or triangulation from two or more reception sites has been used in several studies of elk (Craighead *et al.* 1973, Hornbeck 1979, Shoesmith 1979, Waldrip and Shaw 1979). The technique of aerial location has also been used successfully by Craighead *et al.* (1973), Hornbeck (1979) and Marcum (1979). These procedures are a refinement of early large mammal radio-tracking studies where the purpose of the radio was to enable the investigator to approach the animal close enough to make visible observations (Craighead and Craighead 1965, 1972) and in which extreme accuracy was of little consequence. Signal volume and receiver sensitivity have been found to provide a good indication of the distance between the instrumented animal and the observer (Craighead and Craighead 1972).

Relocations of instrumented elk were obtained from the ground by triangulation or by using the signal strength to judge the approximate distance between the elk and the receiver. Signal strengths for judging approximate distances were checked when elk were in view, and a working

transmitter was left at the base camp for checking the signal strength and direction against a known location and distance. Compass bearings for each signal were obtained by using the centre of an area between two nulls as the strongest signal and thus the true direction of the animal.

Three different antennae were used for ground relocations. A Hy-Gain, Model 23, three-element Yagi antenna or a "Tinkertoy", Model RA-2AK manufactured by Telonics Telemetry-Electronics Consultants, was used in situations requiring hand-held antennae. Two 14-element beam antennae, Model RA-2C, Yagi design manufactured by Telonics Telemetry-Electronics Consultants, were permanently mounted on 12-foot masts located 5 km apart. The permanent installations could be hand-rotated for maximum coverage. The receiver was a Model LA 12 manufactured by A.V.M. Instrument Company, Champaign, Illinois, powered by eight size AA batteries. Earphones were used with the receiver on windy days and when locating elk from an aircraft.

Two Hy-Gain Model 23, four-element Yagi design antennae were used for aerial relocations. One antenna was mounted on each wing strut of a Cessna 172 and connected to the receiver unit via a switch box. The operator was able to listen to either the left or right antenna to determine which side of the aircraft the signal was coming from. Instrumented elk were located by circling the aircraft in the direction of the signal. The signal was of equal strength on the inside antenna when the instrumented elk was within the circle.

3.4 AERIAL SURVEYS

Aerial surveys are widely used to obtain population data for

various species. Two commonly used methods for large mammals are the parallel linear strip and the quadrat. The former consists of flying parallel strips across the area to be censused and counting each animal within the strip. Width of the strip can be determined by the combination of aircraft height and the observer's angle of visibility from the aircraft. The area can be covered in total, or strips can be spaced to cover a particular percentage. The quadrat method consists of flying over a series of randomly selected quadrats within a large area and counting all the animals in each quadrat.

Aerial census will most likely underestimate the population, since some animals are not seen during the survey (Caughley and Goddard 1972). The actual number of animals counted is a minimum estimate, and the number missed is unknown. The inaccuracy of aerial surveys has been attributed to the effects of varying strip width, altitude and speed (Caughley 1974), the effect of different climatic conditions (Lovaas *et al.* 1966) and varying observer abilities (Evans *et al.* 1966).

Population estimates and winter distribution and sex/age surveys were flown using a linear transect method under the supervision of L. Bidlake, a Manitoba Government biologist. A Canadian Armed Forces Kiowa helicopter was flown alternately north-south across the study area at 1-km intervals. Height was maintained at approximately 125 m and flying speed at 100 km/hour. A single aircraft was used during the November and March surveys. Two aircraft were used simultaneously during the January surveys, each flying half the transects. A strip judged to be 1/2 km wide was observed on each side of the aircraft during the census surveys. The observers, one for each side of the aircraft, had extensive experience in aerial big game surveys. The sex/age surveys

were carried out on a seek out and count basis and made no attempt to observe or count all elk present on the Reserve at the time.

Transect lines were all less than 25 km and air time did not exceed three hours on any single flight, enabling the observers to maintain efficiency. Weather conditions were generally good, but visibility varied according to the amount of reflected sunlight, blowing snow or ice crystals present. Groups of elk sighted were circled for counting and recorded by one of the observers on a 1:50,000 topographic map sheet. The pilot and observers were in constant communication via an internal radio system. Elk were classified as antlerless (cow, calf or unknown), adult male or yearling male (spike).

Winter distribution patterns observed during each census were delineated by grid units resulting from drawing indicator lines on a topographic map sheet as described by Hornbeck (1979).

3.5 FIELD OBSERVATIONS

Ground observations of elk were made with the aid of a 20x Bushnell spotting scope mounted on a rifle stock or with 8x Bushnell binoculars. Location, sex, approximate age and time were recorded for sightings of both instrumented and non-instrumented elk.

Ground transportation during the summer of 1979 was a four-wheel drive vehicle supplemented by foot where applicable. In 1980 saddle horses were used in addition to a four-wheel drive vehicle.

RADIO TELEMETRY

Twenty-seven elk were live-captured, ear-tagged and fitted with radio transmitters on the Shilo Military Reserve between December 15, 1978 and March 11, 1980 (see Appendix A for full particulars). The sex and age class of captured elk is shown in Table 1. The number of elk relocations obtained by radio telemetry for each sex and age class are given in Table 2. A complete breakdown of elk relocations is provided in Appendix B.

All radio transmitters did not function throughout the study. Elk 1681 was shot in November 1979 and the collar returned by the hunter. The collar from elk 1693 was recovered in September 1980; the elk had died the previous winter. The collar from elk 1697 was recovered in October 1980, having split and fallen from its neck. The collar originally placed on elk 1680 was recovered in June 1980, presumably having slipped over the head of the elk during grazing. This collar was placed on elk 680 in February 1980. Elk 1678 was observed on March 6, 1980 but no signal could be obtained. The transmitter placed on this elk had obviously stopped functioning.

When radio telemetry is used to remotely fix the position of an animal, the accuracy of the system must be considered. An automatic radio-tracking system utilizing rotating antennae mounted on fixed towers 0.8 km apart used by Tester and Siniff (1965) to study white-tailed deer provided a measurement of accuracy. The angle between

TABLE 1

Number of elk captured and fitted with radio-collars during two winters of trapping, by sex and age class

Winter captured	Female			Male			Total
	Calf	Yearling	Adult	Calf	Yearling	Adult	
1978/79	4	2	13	2	2	1	24
1979/80	0	0	1	0	0	2	3
Totals	4	2	14	2	2	3	27

TABLE 2

Total number of relocations
of radio-collared elk by sex and age class

Year	Female			Male			Total
	Calf	Yearling	Adult	Calf	Yearling	Adult	
1979	50	52	227	30	7	0	366
1980	0	35	295	0	4	55	389
Totals	50	87	522	30	11	55	755

the recorded bearing and the true bearing of the radio-collared deer was found to have a mechanical accuracy of $\pm 5^{o}$. Hornbeck (1979) working in Spruce Woods found that, depending on cover type, an elk could be confidently placed within an area of from 10-26 ha. Success in locating instrumented animals has been found to vary depending on a number of factors such as the shielding effect of hills and timber, condition of the transmitter and receiver batteries, experience of the operator and difference in activity and movement patterns of individuals (Craighead *et al.* 1973). Craighead and Craighead (1972) noted that reflections from large topographic features such as hillsides and cliffs sometimes give false bearings. Collins (1974) working in relatively level terrain with instrumented deer, found little error due to topographic features or vegetation. Deer were repeatedly observed within 50 m of their radio-determined position.

Compass bearings to a signal from a known location provided the following indications of accuracy. In the northeast portion of Zone I an average error of $14^{o}05'$/km, in the north-central portion of Zone I an average error of $1^{o}39'$/km and in the vicinity of Boxer an average error of $1^{o}12'$/km (Table 3). Occasionally, erratic signals were obtained in the northeast portion of Zone I. In one instance an instrumented elk was located by ground search approximately 100^{o} west of the initial bearing. This portion of the Reserve is quite rugged and signal bounce was a problem. Bearings in this vicinity were checked by moving short distances to ensure the initial direction was maintained. Rechecking bearings to eliminate erratic signals lowered the error in this area to 7%. Relocation of elk in the vicinity of the dugouts, when checked against visible individuals, proved to be

TABLE 3

Compass bearings to known transmitter location from various relocation sites

Receiver location (military grid reference)	Distance from transmitter (km)	Error/km	Average error/km
743062	1	5^{o}	
743062	1	10^{o}	
743062	1	32^{o}	$14^{o}05'$
743043	3.5	$6^{o}30'$	
733029	4.5	$6^{o}40'$	
694036	7	$1^{o}17'$	
694036	7	$1^{o}13'$	$1^{o}39'$
709061	4.5	$2^{o}26'$	
703090	5	$2^{o}24'$	
703090	5	$0^{o}36'$	$1^{o}12'$
703090	5	$0^{o}36'$	

extremely accurate. Since relocation distances seldom exceeded 5 km, an elk could be placed within 1/2 km of its actual position.

The random occurrence of varying amounts of buried and exposed metal, resulting from military activity, may have had local effects on telemetry results. Radio signals were difficult to obtain under certain atmospheric conditions due to static or signal depression. Sunspot activity blocked reception. Interference from other radio traffic also blocked reception. This type of interference was more prevalent during the summer of 1979.

RESULTS AND DISCUSSION

5.1 POPULATION TRENDS

The minimum numbers of elk present on the Shilo Military Reserve during January 1978, January 1979 and January 1980 were 412, 412 and 393, respectively (L. Bidlake, unpublished data). During January 1979 and January 1980 the minimum numbers of elk present on the Reserve and Park combined were 568 and 540 (L. Bidlake, unpublished data). The inaccuracy of using aerial surveys to establish reliable population estimates, particularly in uneven terrain, is well-documented (Edwards 1954, Benson 1965, Mence 1969, Heyland 1972, Caughley 1974, LeResche and Rausch 1974, Norton-Griffiths 1976, Miller and Russell 1977, Jacobson and Cook 1978). These inaccuracies, plus the fact that elk were known to be outside the survey boundaries, point out the difficulty in estimating the total population of Spruce Woods elk. All factors considered, the Spruce Woods elk population was likely 600-700 animals between 1978 and 1980. The estimates of elk population given by Hornbeck (1979) of 515 in 1977, 609 in 1978 and 919 in 1979 cannot be regarded as minimum numbers, since he indicates the survey figures were corrected to account for areas not covered during the surveys.

The increase from 145 elk as documented by Ransom (1969) to 568 elk (L. Bidlake, unpublished data) represents an approximate annual increase of 39% over the ten-year period from 1969 to 1979. Hornbeck

(1979) calculated the population increase from 1977 to 1978 as 17%. Bidlake (unpublished data) found a total of 568 elk in 1979 and 540 elk in 1980. Thus, the population has stabilized its numbers, or is undergoing stabilization. There are indications that the population increase during the early 1970's may have, at times, exceeded the 39% average. Yearly increases of 50% have been reported for an elk population (Martinka 1969) but annual increases of less than 20% are more common (Murphy 1963, Lovaas *et al.* 1966, Peek *et al.* 1967, Flook 1970, Kimball and Wolfe 1974). The mild conditions experienced during the past two winters will likely result in reduced calf mortality. It may therefore be several years before the actual population trend becomes apparent.

The composition of groups of Spruce Woods elk was recorded during this study and by Bidlake (unpublished data). Aerial survey results are shown in Table 4.

The three-year average bull to antlerless elk ratio during the January flights was 15:100. The three-year average bull to female (including calves) ratio during the November sex/age survey was 9:100. The differences between January and November ratios are due to variations in survey technique. There was no attempt during the November surveys to find all elk on the Reserve.

The bull to antlerless ratio for elk at Duck Mountain, Manitoba varied between 15:100 and 56:100 during the period 1969-1975 (Davies 1979). The average ratio over the same seven-year period was 31:100, only slightly lower than the 37:100 ratio reported for adult elk in western Canadian mountain parks (Flook 1970). The lower bull to antlerless ratios observed on the Reserve do not necessarily represent

TABLE 4

Numbers of elk observed on the Shilo Military Reserve during aerial surveys, 1978-1980
(Percentage of population is shown in brackets)

Date	Bull		Antlerless			Total	Bull:antlerless ratio	Calf:cow ratio
	Adults	Yearlings	Cows	Calves	Cows and calves			
January 1978	52(13)	19(5)			341(82)	412	17:100	
1979[a]	53(13)				359(87)	412	13:100	
1980[b]	53(14)				340(86)	393	14:100	
November 1978	1(1)	12(5)	167(71)	54(23)		234	6:100	32:100
1979	7(2)	26(8)	179(55)	116(35)		328	10:100	65:100
1980	18(6)	19(6)	198(62)	82(26)		317	12:100	41:100

[a]This survey was extended to include the Park. The total number of elk counted was 568 (101 bulls, 467 antlerless).

[b]This survey was extended to include the Park. The total number of elk counted was 540 (91 bulls, 449 antlerless).

the ratio present in the overall population since elk were present in other areas at the time of survey. Bull to antlerless ratios in 1979 and 1980 were 22:100 and 19:100, respectively, when elk observed in the Park were included with those observed on the Reserve. The bull to antlerless ratio in the Spruce Woods is, however, lower than in other Manitoba elk populations.

The calf to cow ratios observed during the November surveys were 32:100 in 1978, 65:100 in 1979 and 41:100 in 1980. The mean calf to cow ratios obtained from observations in July 1979 and July 1980 were 32:100 and 43:100, respectively. The summer and fall ratios of 1980 are similar (43:100 and 41:100, respectively). The summer mean ratio of 32:100 in 1979 is less (approximately 1/2) than the fall ratio of 65:100. During the summer estimates, care was taken to include only those groups that could be counted in total, and under such conditions that calves were visible. It is possible that the comparison of July ratios is not valid. The 1978 breeding season may have been delayed. A delay in breeding could have been the result of a disturbance, the result of a low male to female ratio or the result of breeding by yearling bulls (Prothero *et al.* 1979). The smaller ratio in 1980 may also be a function of a larger number of non-breeding females due to the higher ratio the previous year. Female to calf ratios always include a proportion of non-breeders.

Knight (1970) compared production figures for seven elk herds and found the average calf to cow ratio to be greater than 50:100. In the

Sun River herd, calf to cow ratios were below average (18:100 to 40:100) between 1961 and 1965, during a time of recovery. The Spruce Woods elk are, by this criterion, also below average. Calf to cow ratios below 50% have been found in other areas (Peek *et al.* 1967 in Montana, and Kimball and Wolfe 1974 in northern Utah). Peek *et al.* (1967) suggested that a fluctuating calf to cow ratio might be characteristic of cervid populations on overstocked ranges.

A relative scarcity of males in an elk population does not affect reproduction (Murie 1951). Differential survival favouring females has been reported from elk (Peek and Lovaas 1968, Martinka 1969, Flook 1970). Disproportinate survival has been reported from other cervids by Cowan (1950) and Robinette *et al.* (1957).

The composition of the male segment of an elk population may be more important than the bull to cow ratio. Prothero *et al.* (1979: 164) point out that,

> "If yearling bulls are acting as breeders, one might expect to see (1) cow-calf groups containing yearling bulls that occasionally exhibit rutting behavior and that remain with the cows and calves throughout the rut, (2) calving approximately 1 month later than usual, and (3) smaller-than-normal calves entering the winter."

This latter point could affect the population because of the possibility of increased mortality. The calf to cow ratio noted for the Spruce Woods elk in July 1979 could be the result of yearling bulls acting as breeders. If breeding is one month later, the July ratio would be lower than the November ratio. Prothero *et al.* (1979) also point out that different selective pressures would occur if yearling bulls contributed significantly to the breeding. Yearling bulls would contribute more

genetic variability, a circumstance of great value to animals forced to cope with rapidly changing environments. The importance of adaptability and diversity is pointed out by Phillips (1976: 3-4) who, in a discussion of the Tule elk, states,

> "The elk become quite specialized in adapting to their reduced numbers in a constricted habitat and may well lose their wide adaptability that exists under diverse habitat conditions. Second or third generation elk from a small reserve or zoological garden if reintroduced to a portion of original elk habitat, unlike their ancestors, may not be able to adapt — indeed, may not be able to survive."

The male to female ratio that presently exists in the Spruce Woods elk population compares favourably with viable elk populations in other parts of North America. It is unlikely that the population is being negatively affected by a scarcity of males. Yearling bulls comprise less than half of the bull segment of the population. The male to female ratio is approximately 25:100. The calf to female ratio average is 46:100.

Mortality in Spruce Woods elk has been, until recently, little affected by predation (including hunting). The coyote is the only confirmed natural predator of elk present in the Spruce Woods, although reports of wolves and cougar do occur. It is unlikely that coyotes pose a major threat to elk. Murie (1951) reported that, although coyotes do kill elk, the majority of the elk they consume is carrion. Illegal elk hunting has been a sporadic problem in the area (R. Noel, pers. comm.). Some elk have also been shot accidentally during the deer hunting season. The number of elk poached or taken accidentally are not large enough to seriously deplete the population. The effects of the elk hunting season, instituted in the fall of 1979, on the

Spruce Woods population have yet to be determined.

The relationship between numbers of elk and military training is not clear; historically, no attempt was made to correlate the two. Elk mortality due to military activity has been noted, but the extent to which it occurred is unknown. It is possible that elk mortality increased during the heavy training schedules associated with World War II and the Korean War, but little is known of the status of the elk population during those periods.

There is no evidence to indicate that the present level and type of military activity is a major factor in elk mortality. The apparent increase in the elk population during the 1970's coincides with the beginning of training exercises by the West German armed forces. During the 1960's, military use of the Reserve declined; it is possible that the elk population began to expand at this time, although reports of large numbers of elk and a general awareness of an increasing elk population did not surface until the mid-1970's.

West German military activity has resulted in two factors which would benefit the resident elk population. First, due to the nature of the training exercises, the areas of impact of live artillery shells have become relatively consistent from year to year. The majority of impacts are confined to specific portions of the Reserve rather than scattered randomly throughout. This concentration of impacts would reduce accidental elk mortality, compared to scattered random impacts characteristic of Canadian forces training exercises. It would also allow elk to adapt to military activity by avoiding portions of the Reserve where impacts were occurring regularly. The second factor provided by the West German forces is the reintroduction of fire as

part of the yearly cycle on the Reserve. The historical range of elk across North America is associated with the presence of wild fire (Leopold 1966). Gaffney (1941: 451) states,

> "Natural closing-in of the old burns by forest in consequence of fire protection has reduced the carrying capacity, but has not in itself, made the area untenable for elk."

5.2 SEASONAL DISTRIBUTION AND MOVEMENTS

Elk on the Shilo Military Reserve are clumped rather than uniformly distributed. Cow groups of more than 20 are common; bulls tend to be solitary or in small groups except during the rut.

Relocations of instrumented elk, observations of non-instrumented elk and the presence of elk tracks or feces indicate the entire Reserve is used by elk. Elk relocations were irregular during winter and do not provide conclusive information regarding use at that time. The use of aerial survey results and ground observations of elk and elk sign in conjunction with the telemetry data did, however, provide information on areas of concentrated winter and summer use (Figs. 3 and 4).

Elk on the Reserve exhibited differential distribution by sex. Results of aerial surveys in January and March showed that adult bulls were more prevalent on the eastern portion of the Reserve (Figs. 5 to 8). Observations of non-instrumented elk during 1979-1980 also showed that the percentage of bull elk was, overall, significantly higher on the eastern portion (Table 5).

Relocations of instrumented elk support differential distribution by sex (Fig. 9). No yearling or adult males were trapped on the west side of the Reserve (Appendix A).

Figure 3. Areas of concentrated winter use by elk from radio relocations and observations.

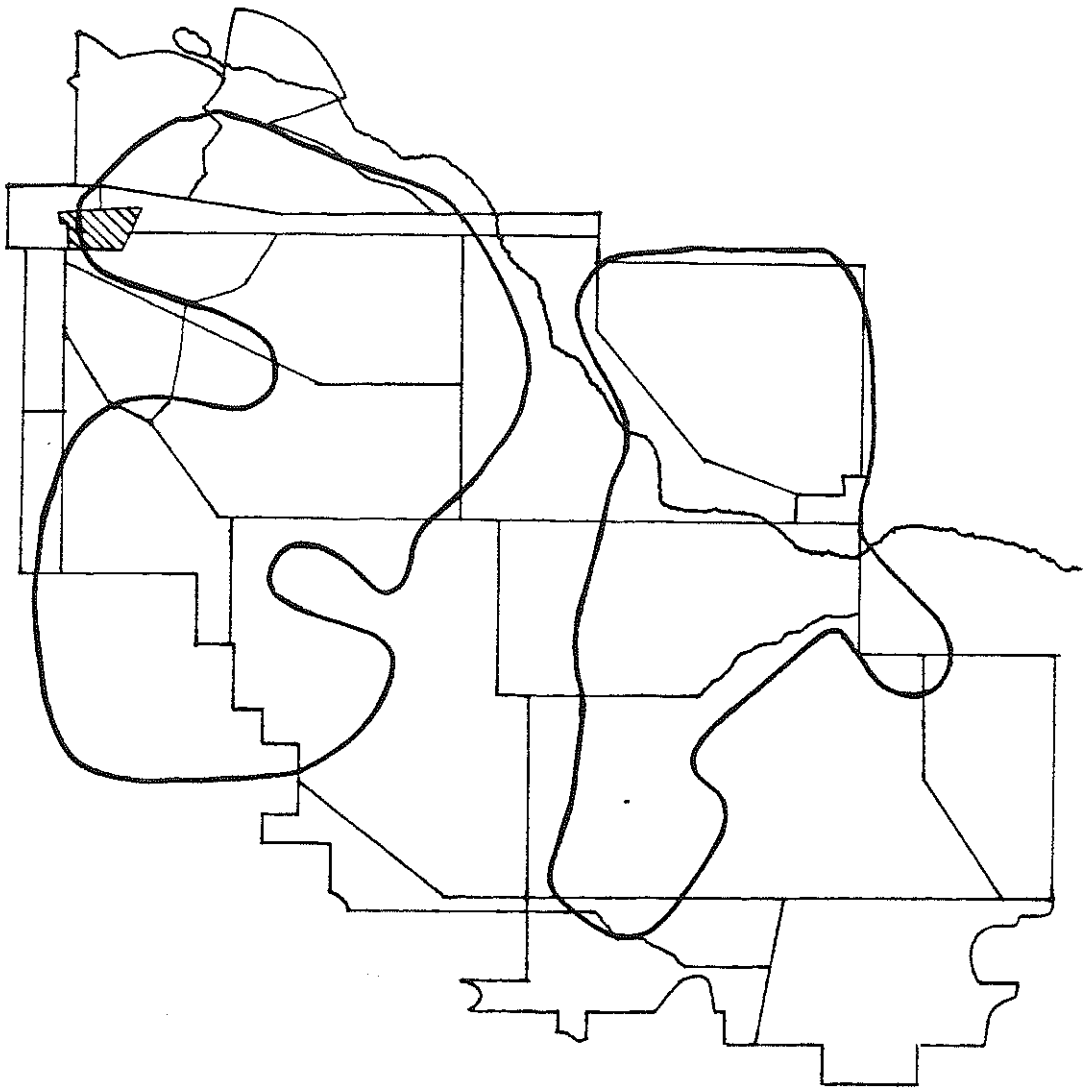


Figure 4. Areas of concentrated summer use by elk from radio relocations and observations.

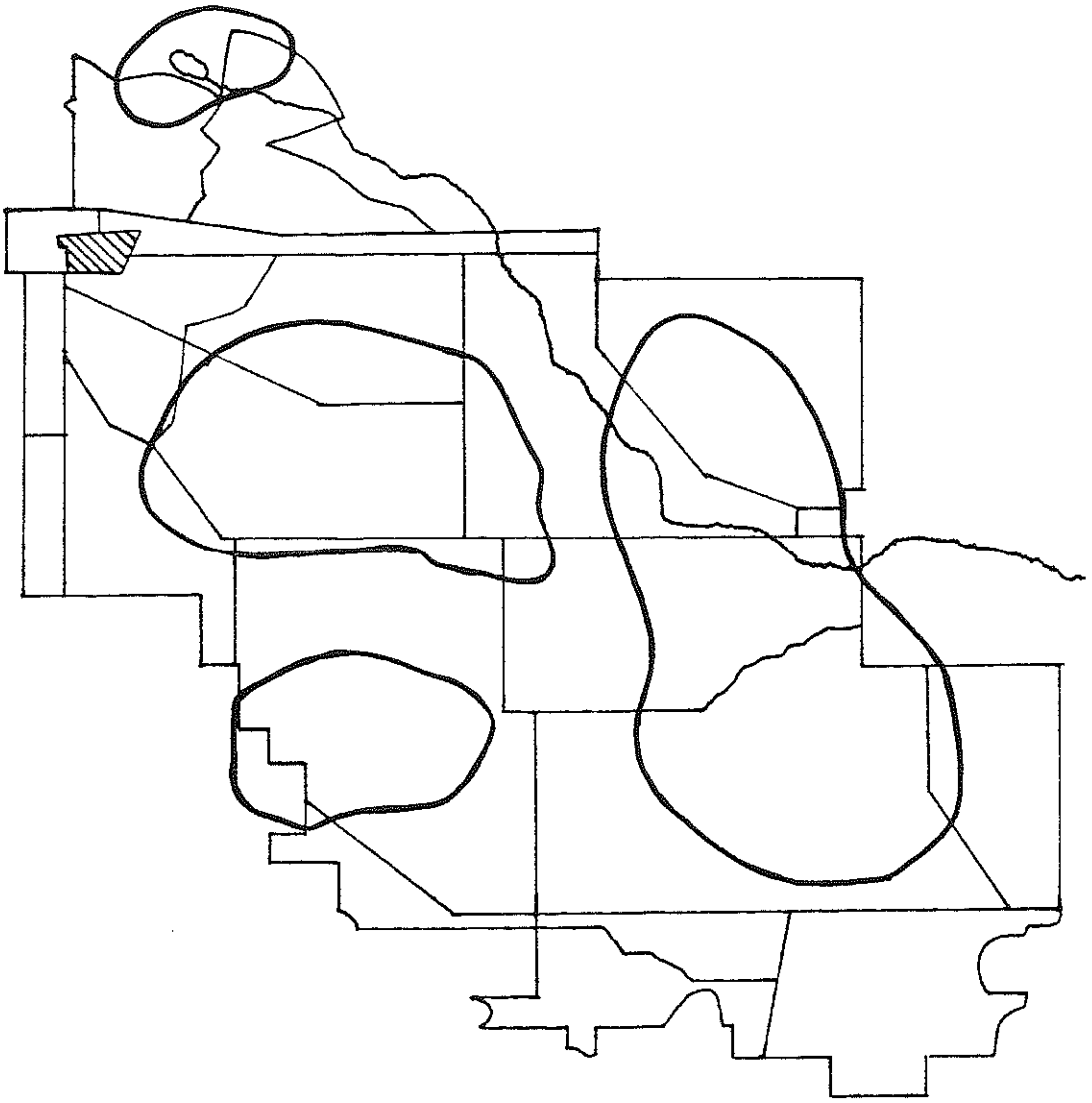


Figure 5. Elk distribution on the Shilo Military Reserve during an aerial survey, January 1978.


mixed group


cow group

bull group or single bull

341 cows and calves

71 bulls

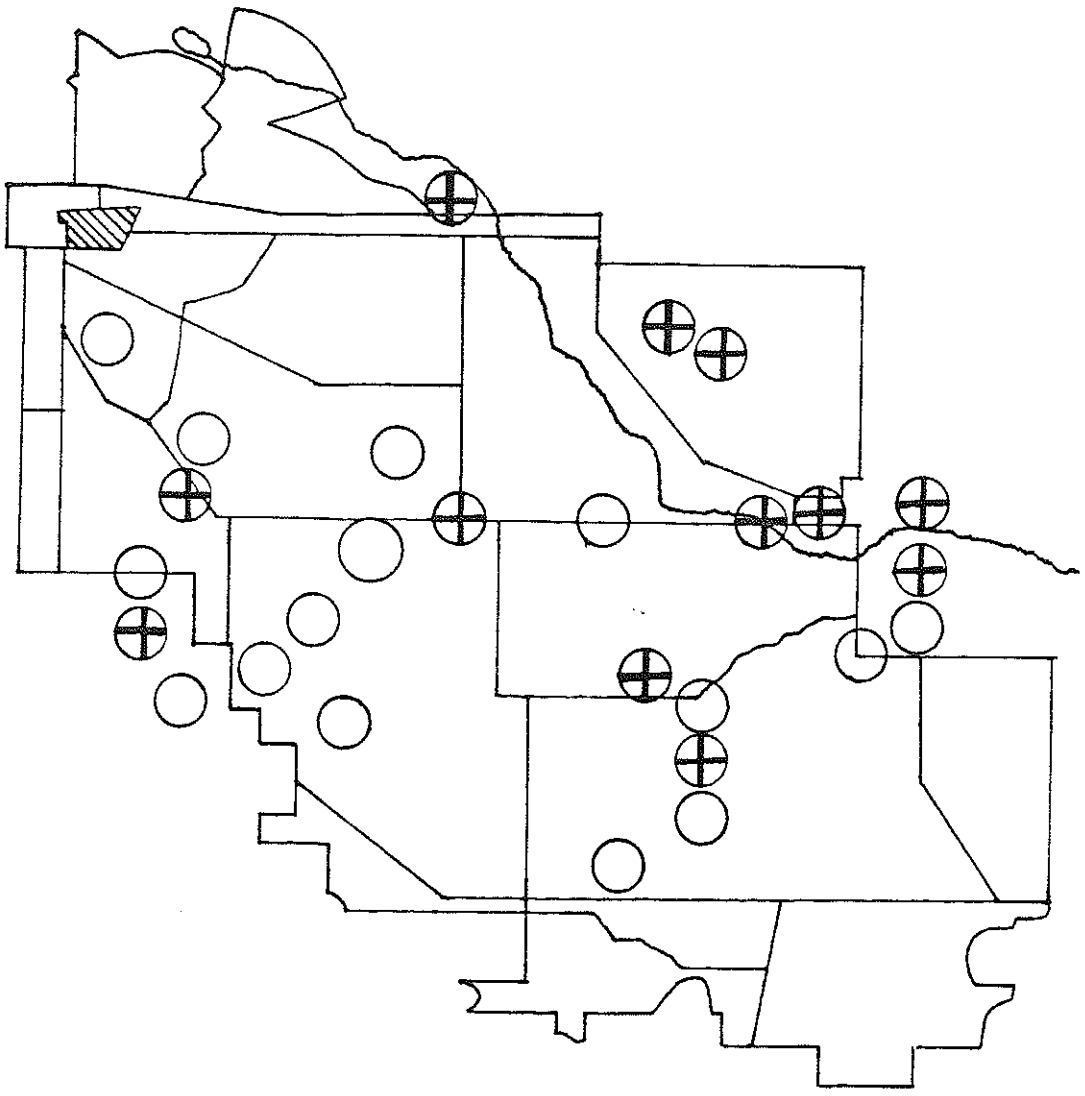


Figure 6. Elk distribution on the Shilo Military Reserve during an aerial survey, January 1979.


mixed group


cow group


bull group or single bull

359 cows and calves

53 bulls

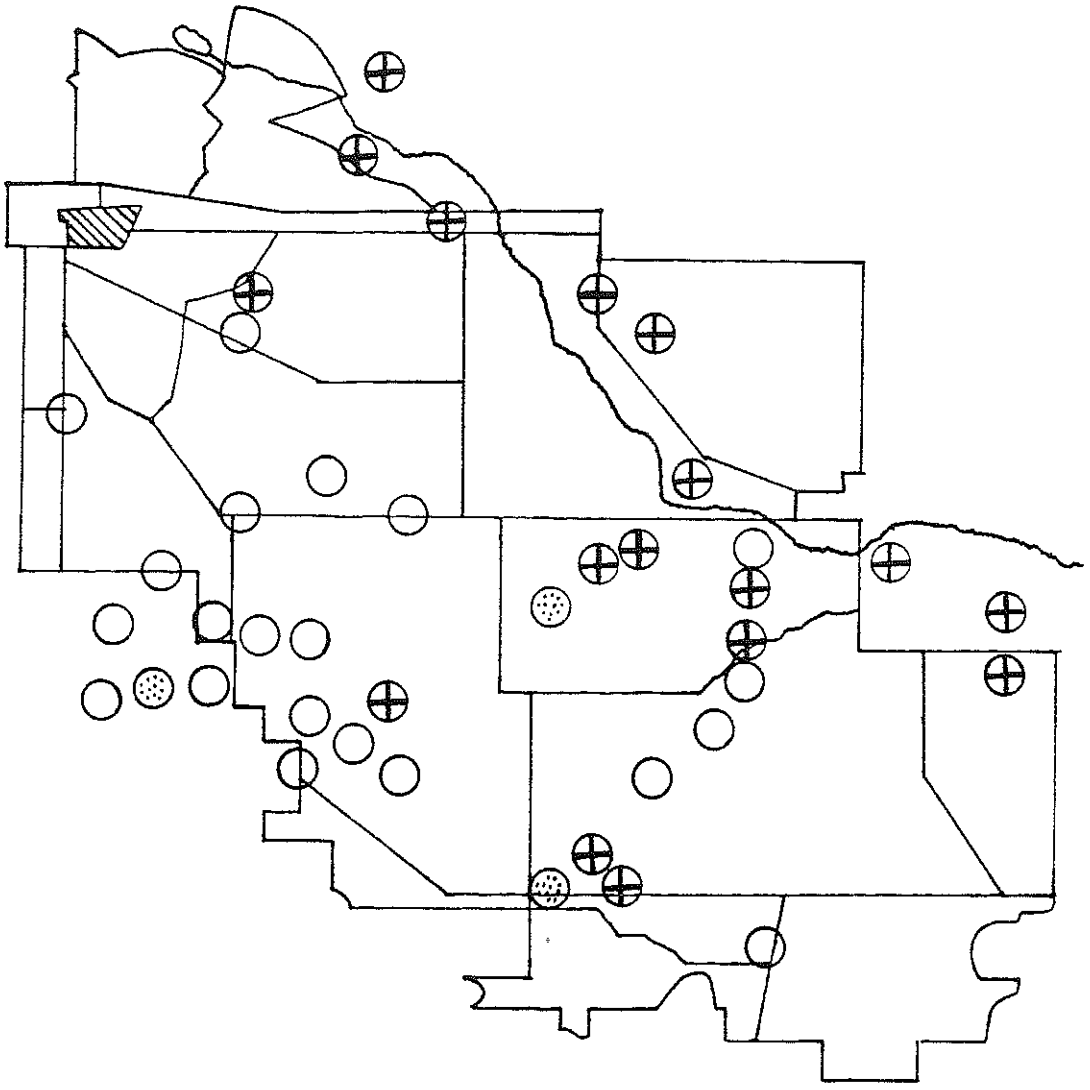
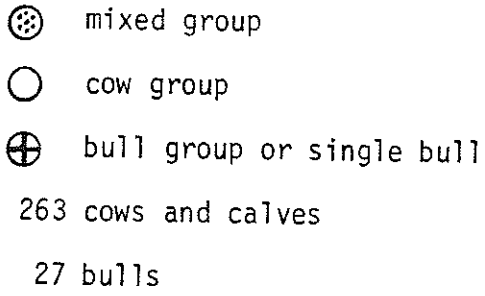


Figure 7. Elk distribution on the Shilo Military Reserve during an aerial survey, March 1979.



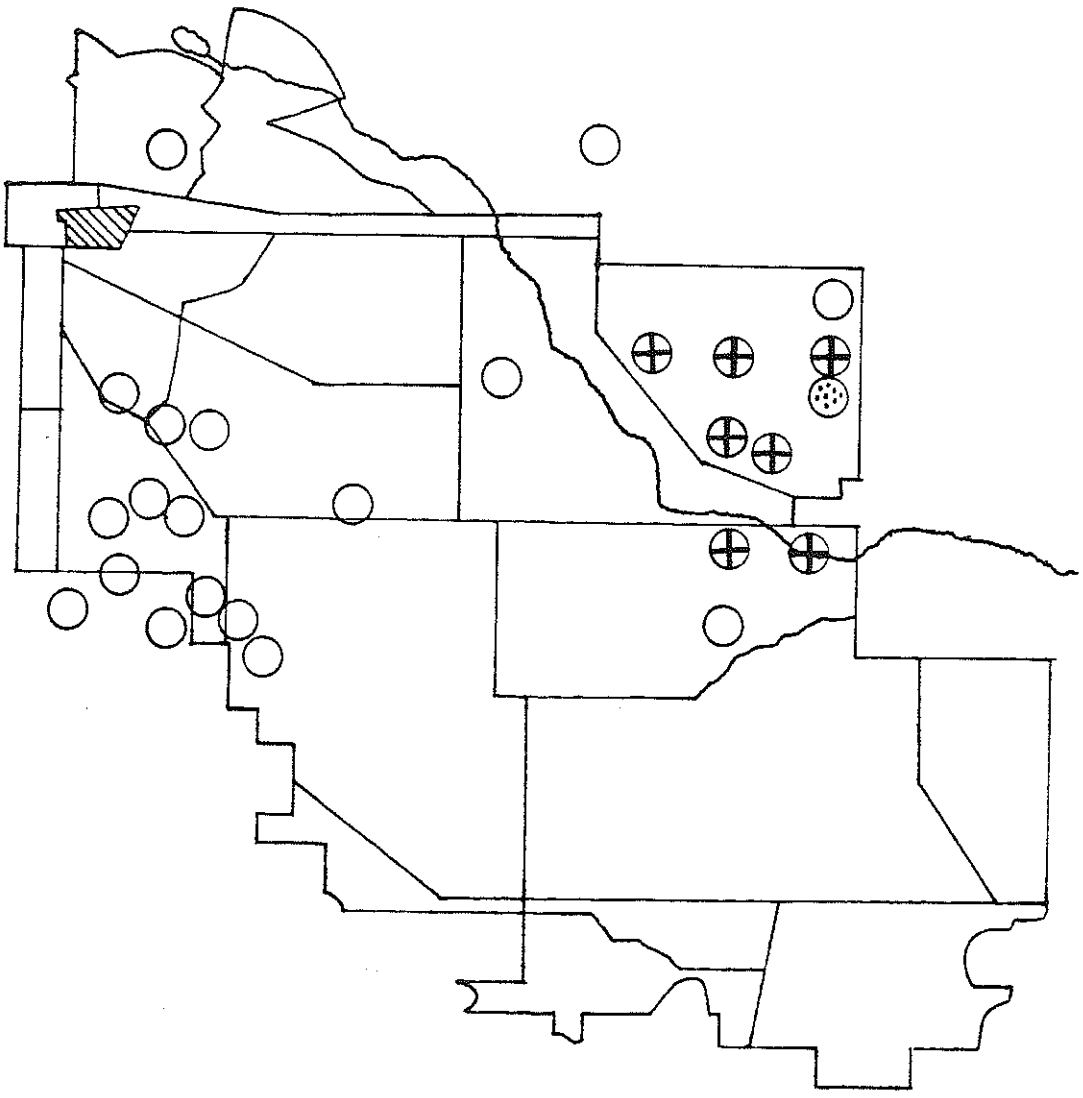


Figure 8. Elk distribution on the Shilo Military Reserve during an aerial survey, January 1980.


mixed group


cow group


bull group or single bull

340 cows and calves

53 bulls

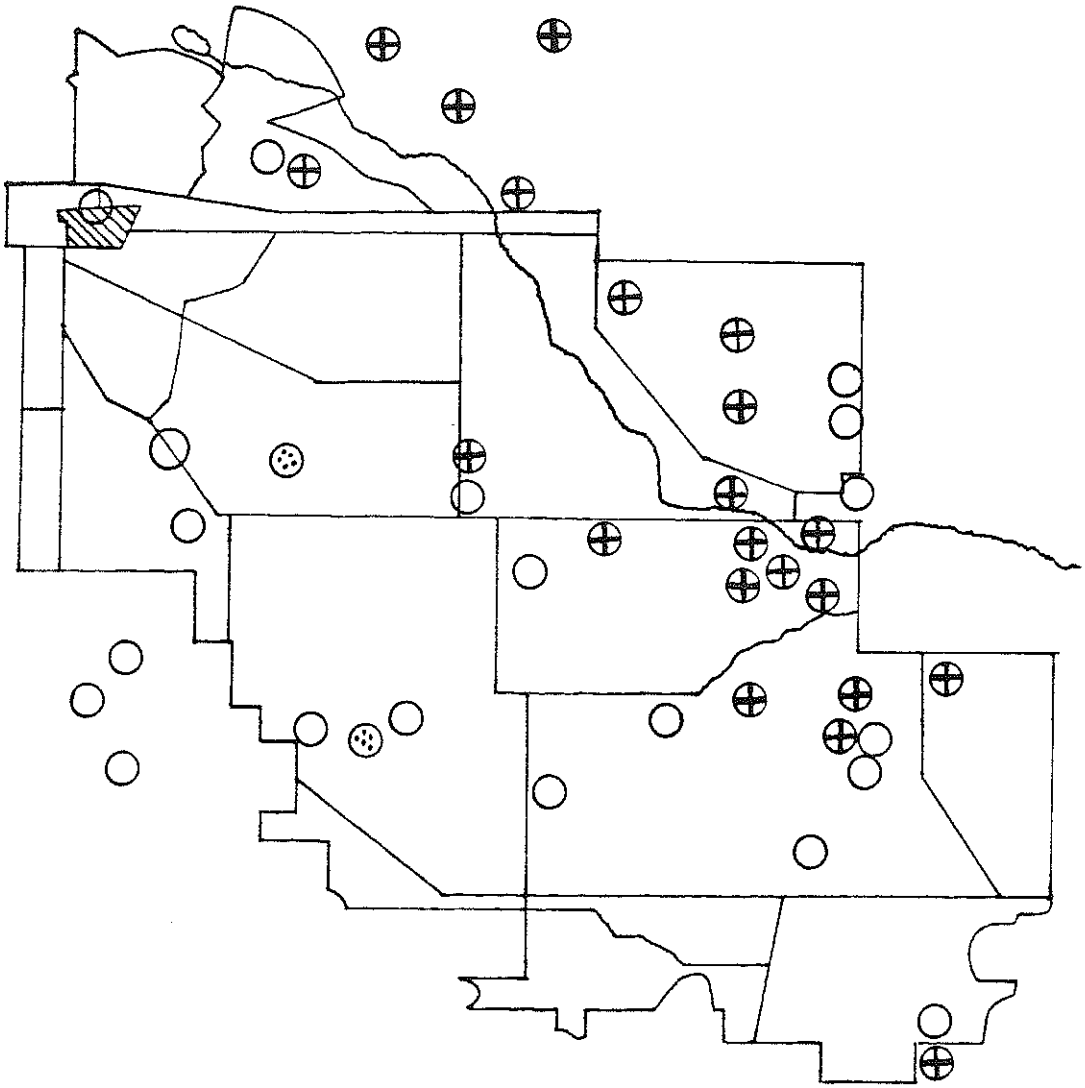


Figure 9. Distribution of instrumented female and adult male elk from 650 relocations obtained 1978-1980. Female distribution is divided by trap site.

• male elk

▫ female elk from Trap 4

✱ female elk from Trap 8

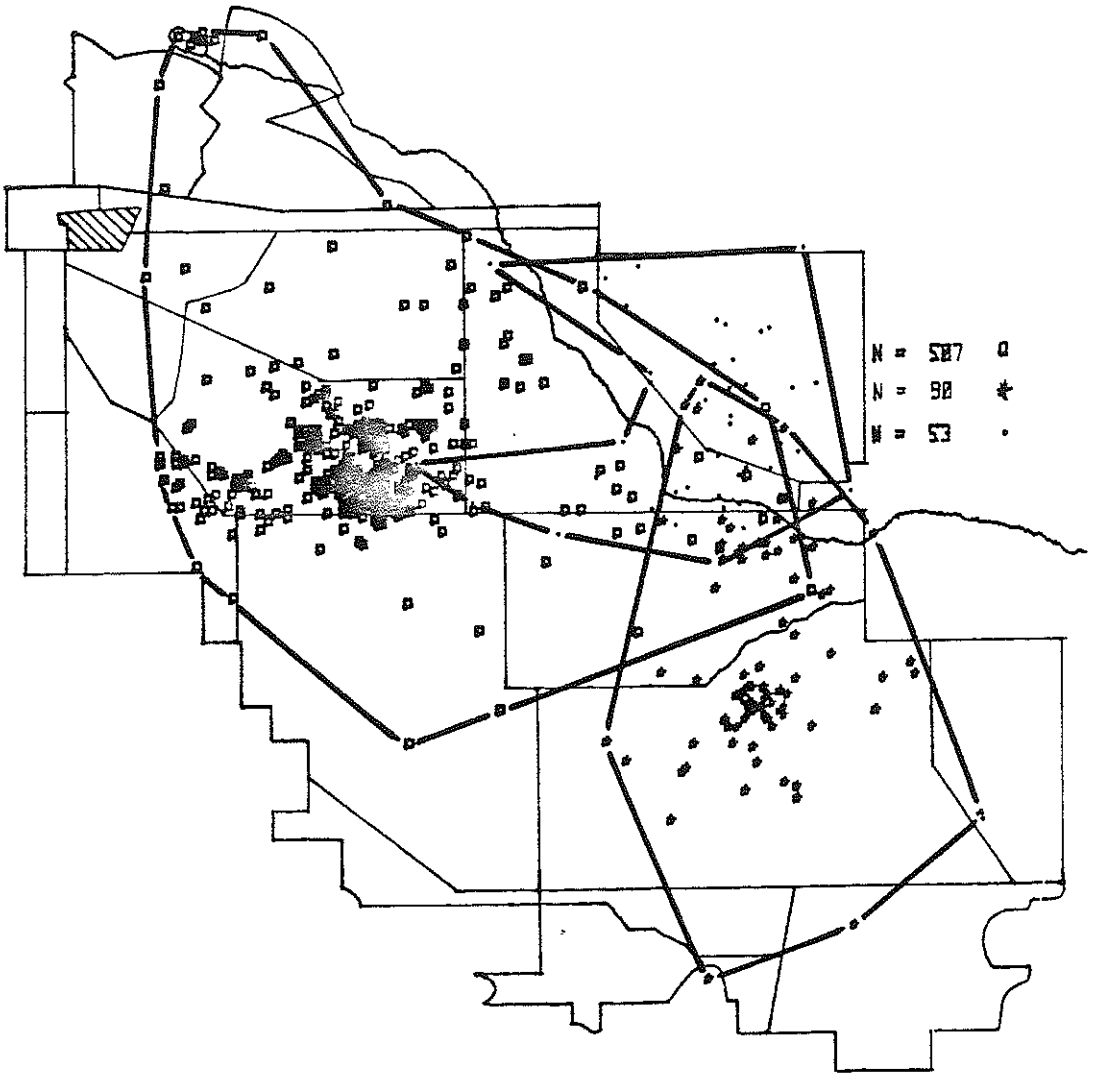

N = 587
N = 90
N = 53

TABLE 5

χ^2 test of male-female distribution, 1979-1980

	West	East
Bulls	16	44
Cows	460	327
χ^2		22.87

3.84 = significant

$\mu = 0.05$

These results are consistent with Hornbeck (1979) who found that a greater percentage of elk in the Park were males. Differential distribution of elk by sex has been reported in migratory elk (Altmann 1956, Peek and Lovaas 1968, Knight 1970) and in non-migratory elk (Eveland *et al.* 1979, Franklin *et al.* 1979, Moran 1973).

Distribution of elk during the rut differs from distribution during the remainder of the year. In November 1978 and 1979, bulls had already separated from the cow groups, but, in 1980, many adult bulls were still with cow groups (M. Shoesmith, pers. comm.). This suggests a delay in rutting activity in 1980.

Elk do not frequent the eastern half of Zone I in winter. No relocations or ground observations of elk or elk sign indicated use of that portion of the Reserve. This phenomenon might indicate intraspecific distribution between elk and white-tailed deer, but the presence of deer in the area is unlikely to preclude use by elk.

Local variation in snow depth may be a major factor in winter elk distribution. The winter of 1979-1980 was mild with less than normal snowfall. Winter snow depths on the Reserve were well below 75 cm except for occasional drifted areas. Hilltops and ridges were virtually snow-free. Exposed hillsides had snow depths which reached to mid-calf (30 cm) or less. Ground vegetation was available in most areas. Sheltered hollows where snow depths approached mid-thigh (75 cm) were scattered and easily avoided. The atypical winter during this study likely resulted in elk distribution that differed from winters with greater snowfall.

Parturition likely occurs on the spring range wherever conditions are suitable. Murie (1951) reports calving occurring on winter, spring

and summer range in various parts of the western United States, and, by omission, make the presence of a communal calving area for an elk herd an unlikely probability. Communal calving grounds have not been noted on elk ranges. It is unlikely that the Epinette Creek area is favoured for calving, although calving may take place in the vicinity. There are no relocations showing that instrumented female elk frequent the Epinette Creek area during the calving season. On June 2, 1979, the tracks of a female elk accompanied by a new calf were observed crossing the ridge 0.5 km south of the swamp at approximately the midpoint of the south boundary of Zone H. The elk were moving south and may have come from the swamp. A cow and a calf of the year were seen June 4, 1980, north of Forest Hills Ranch approximately 3.5 km east of the Zone 8 trap (Roy Jewsbury, pers. comm.). A calf was killed by a vehicle on Highway 5 very near this location on June 17, 1980. On June 29, 1980, the tracks of five female and three calf elk were noted crossing the east boundary of Zone 8, 3 km north of Epinette Creek.

Calving occurs on other parts of the Reserve. Hornbeck (1979) saw a calf estimated at one or two days old near the southern boundary of Zone G due south of Boxer. Military personnel reported a new-born calf near the Zone 4 trap during the first week of June 1979 (Captain W. Gordon, pers. comm.). A calf judged to be one to two weeks old was observed near the southern boundary of Zone 4 on June 11, 1979. The calf was hidden and the female approached, suckled it and left again while the calf was under observation. The calf was likely born in the vicinity, although it could walk and appeared very mobile.

Calves were first seen in the vicinity of the dugouts on June 16, 1979 and regularly after that date. These calves were in association

with female groups and able to travel with the adult animals. Military personnel reported young calves in two groups of elk sighted in Zone F approximately 2 km northwest of Cologne battle run on June 24, 1980 (Sgt. Burgess, pers. comm.). Eight calves were sighted with 25 female elk in the south-central portion of Zone I on July 1, 1980.

The lack of seasonal range preference exhibited by Spruce Woods elk is due, in part, to the interspersion of habitat types and the absence of altitudinal regimes. The habitat preference of elk varies throughout the North American range. The elk is a subclimax, temperate zone species which is able to thrive on disturbed vegetation (Leopold 1966). Elk in Riding Mountain prefer burned-over forest to climax forest, and climax grassland to the seral stages resulting from cattle grazing (Blood 1966). Knight (1970) found that preferred habitat changed seasonally. Spring range was predominantly grassland. During the summer, elk moved to high-altitude forb and burned areas and increased their use of timbered areas as fall approached. Fall forage was predominantly grass, but use of timbered areas was extensive. Winter range consisted of grass and savannah areas but varied considerably between years according to weather. Elk diets vary considerably, seasonally, yearly and geographically (Mackie 1970, Kufeld 1973, Rickard *et al.* 1977, Hobbs *et al.* 1979, Hunt, 1979, Marcum 1979).

Elk distribution and movement may be a function of habitat preference and may result, in part, from the apparent increase in overall numbers. As the population increases, the greater number of animals wintering in the cow-calf groups may be causing expansion into areas of habitat that may not have been used previously. These areas may be less desirable or may simply not have been required.

There are preliminary indications that elk distribution on the Reserve may, in part, be predicted by the existence of discrete herds within the overall population. A comparison of the ranges of the elk trapped as adults suggests two distinct range-use patterns. Elk from Trap 4 were generally restricted on the northwestern portion of the Reserve, while those from Traps 8 and G utilized the eastern portion (Fig. 9). The area of overlap of these two "herds" and the area of overlap between male and female ranges is the southern part of Zone H. The water and cover available is important, if not critical, to all elk on the Reserve. The existence of another "herd" is suggested by frequent sightings of elk, including aggregations of more than 50 animals, in the southern half of Zone F and on the adjacent private land. Weekly attempts at relocating instrumented elk from points along the southwestern boundary of the Reserve, during the summer of 1980, were unsuccessful even though elk were known to be in the area.

Avoidance of some areas may be a learned response. Elk have been shown to exhibit learned responses (Allred 1950, Murie 1951, Knight 1970, Craighead *et al*. 1972, Houston 1979).

Hayden-Wing (1979) stated that elk distribution appeared to be influenced primarily by human activity and secondarily by snow depth and vigor of browse. He further postulated that heavy deer use of an area might restrict elk use by reducing browse so that it cannot support large numbers of elk. Telfer (1978) surmised that elk winter utilization of an area was not strongly related to browse availability but may be related more to traditional wintering areas and disturbance.

Kelsall and Telfer (1971) state that adverse snow conditions are a limiting factor for elk in winter. Nasimovitch (1955) also report snow

depth as a critical factor for members of the genus *Cervus* in Russia. Gaffney (1941) found that mature elk move without difficulty in loose snow up to about 40 inches (101 cm), in packed or crusted snow up to about 30 inches (76 cm) and that the amount of snow in which an elk could winter was affected by topography, age and condition of the animal and the composition, height and volume of the palatable vegetation.

Elk on the Reserve did not use separate seasonal ranges. Radio relocations showed that, for the majority of instrumented elk, seasonal ranges overlapped or could not be separated. The combined seasonal ranges of female elk from Trap 4 show similar range-use patterns in summer and fall and also in winter and spring (Figs. 10 to 13). The spring, summer and fall ranges all show an activity centre at the dugouts in Zone E. Vegetation in the immediate vicinity of the dugouts is willow, surrounded by aspen containing many open areas. Extensive grassland areas occur to the west, north and east.

The seasonal ranges of elk 1641 (Fig. 14) and elk 1683 (Fig. 15) are two "typical" patterns of adult females within the overall Trap 4 range. Elk 1685, a yearling female in 1979, exhibited different summer and fall range-use patterns (Figs. 16 and 17). Apparently this elk used different areas as summer ranges during 1979 and 1980. During the fall of 1980, elk 1685 used the Sewell Lake area during the early part of the rut and the southern part of the "typical" fall range during the latter part.

Adult female elk from Trap 8 did not use the same seasonal ranges as the Trap 4 elk. The range for these elk was located on the eastern portion of the Reserve.

Figure 10. Summer range of female elk from Trap 4 during 1979 and 1980.

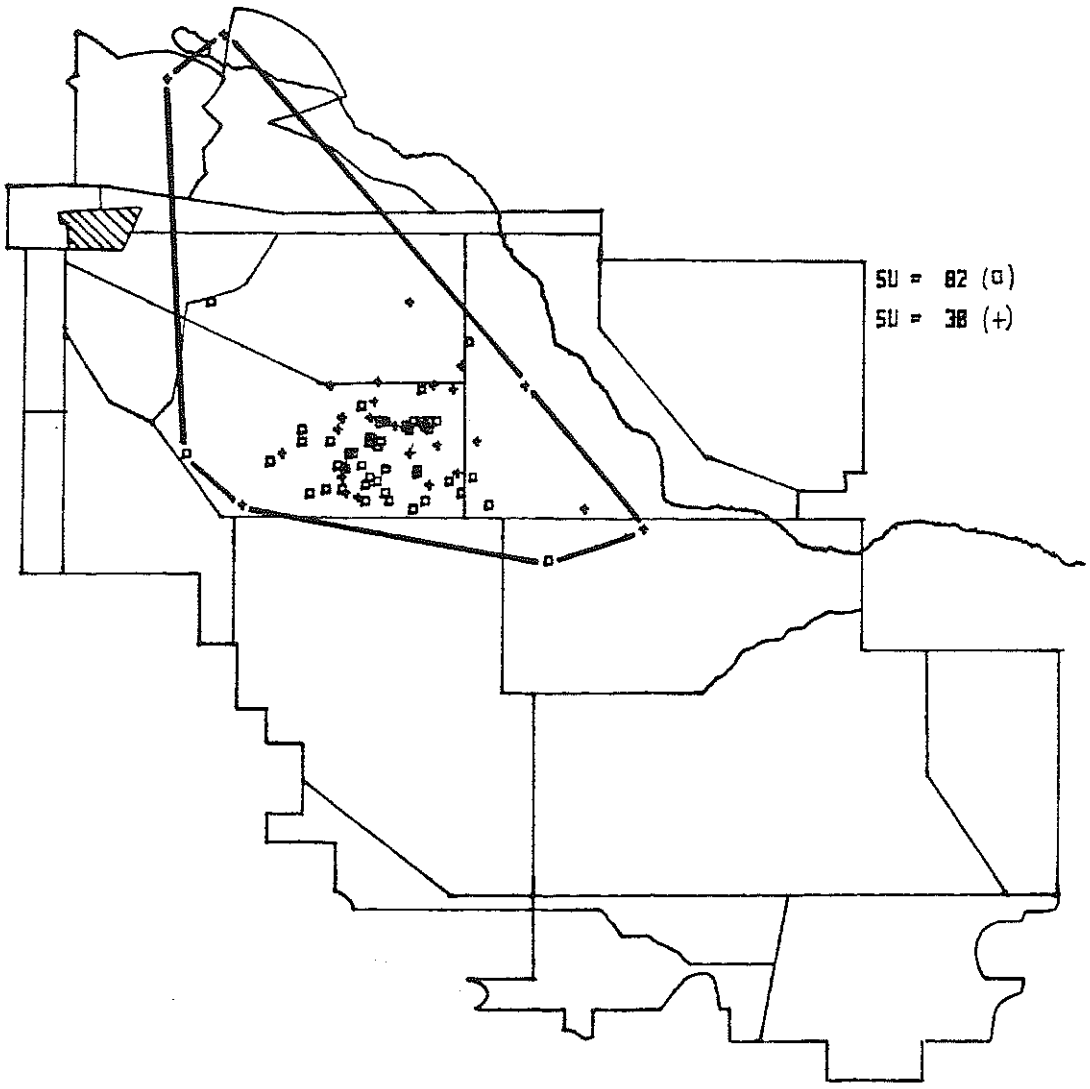
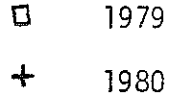

SU = 82 (□)
SU = 38 (+)

Figure 11. Fall range of female elk from Trap 4 during 1979 and 1980.



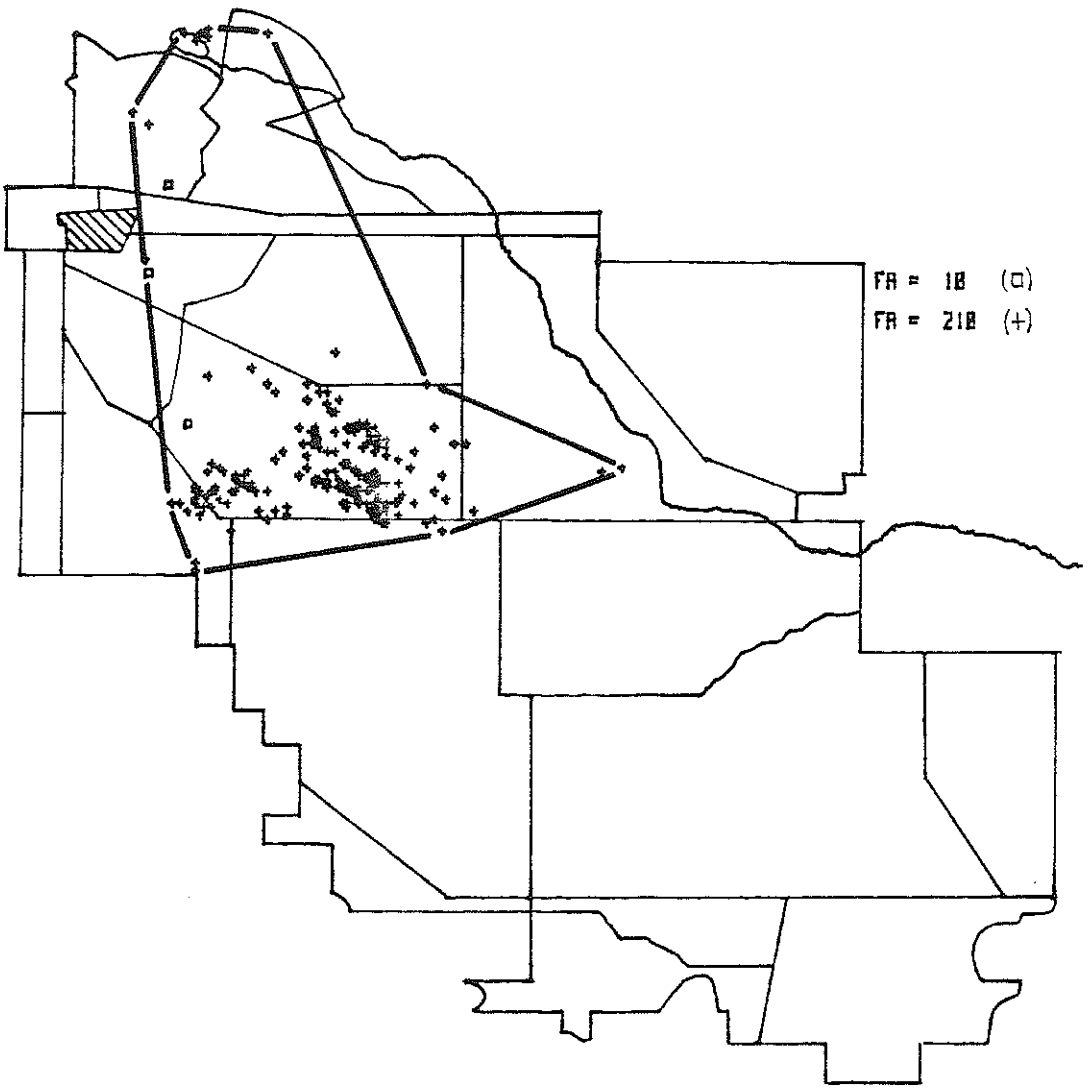

FR = 18 (□)
FR = 218 (+)

Figure 12. Winter range of female elk from Trap 4 during 1979 and 1980.

1979

\+ 1980

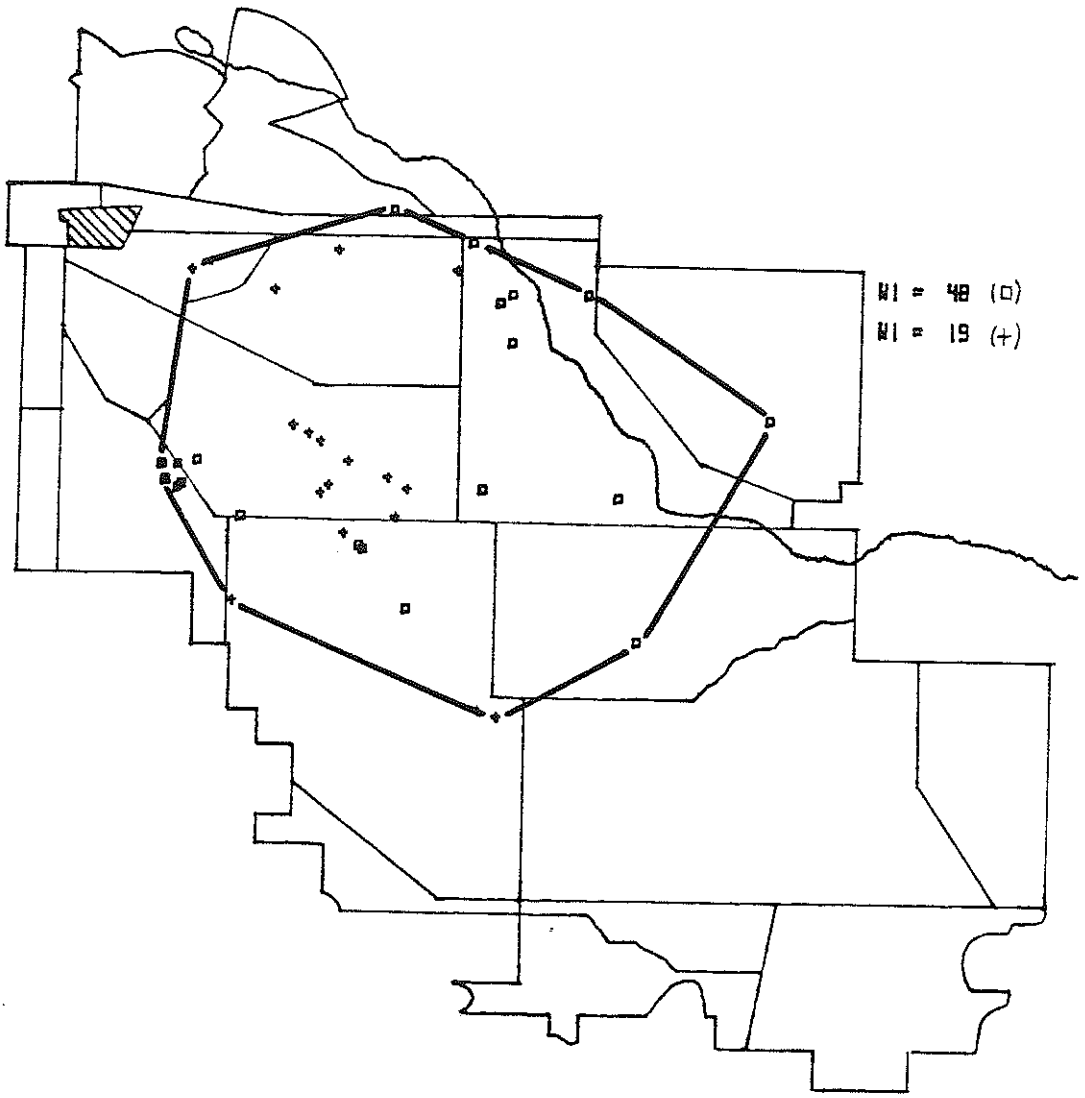
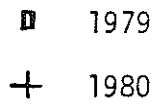

N1 = 48 (□)
N1 = 19 (+)

Figure 13. Spring range of female elk from Trap 4 during 1979 and 1980.



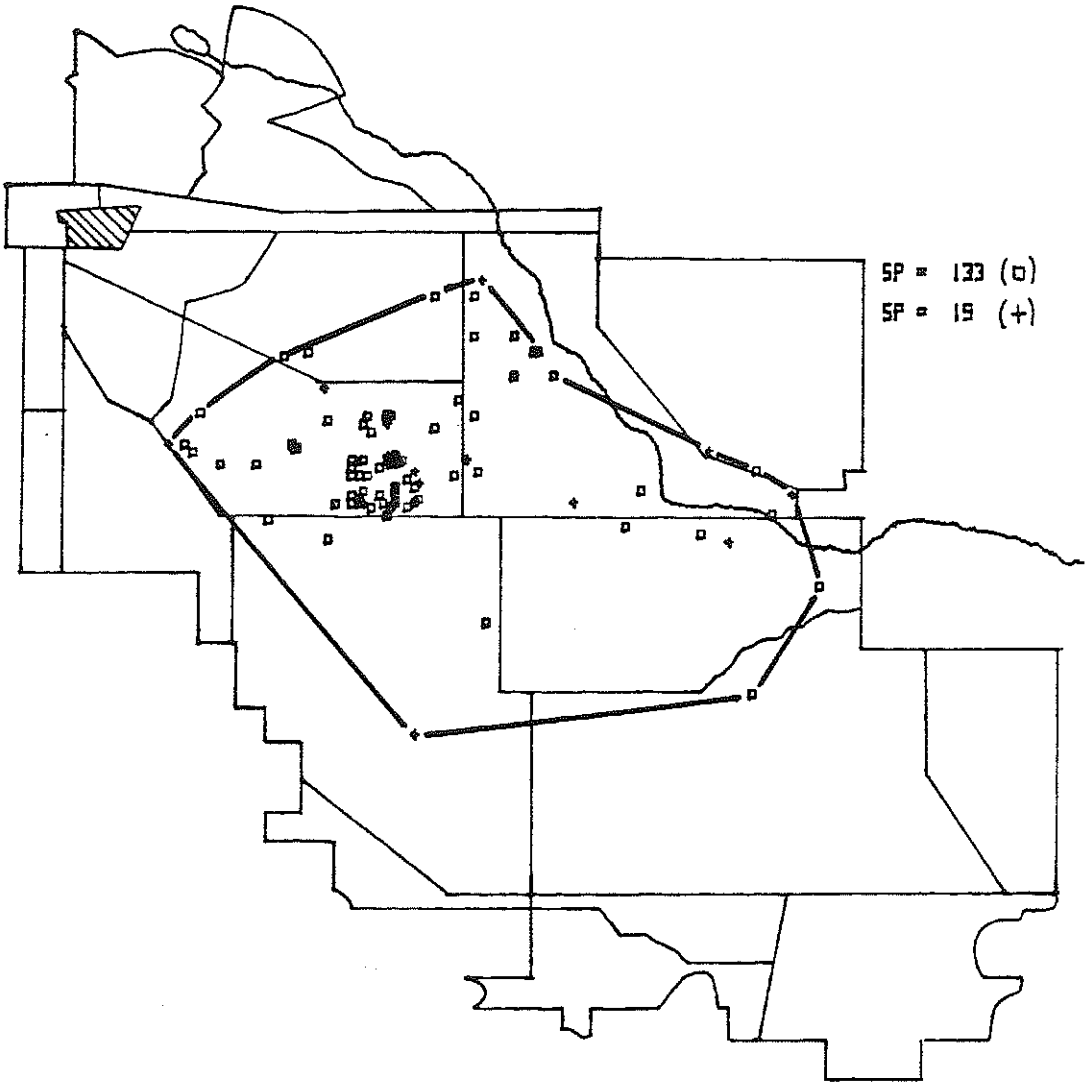

SP = 133 (□)
SP = 19 (+)

Figure 14. Seasonal ranges of elk 1641.

——— spring

------ summer

..... fall

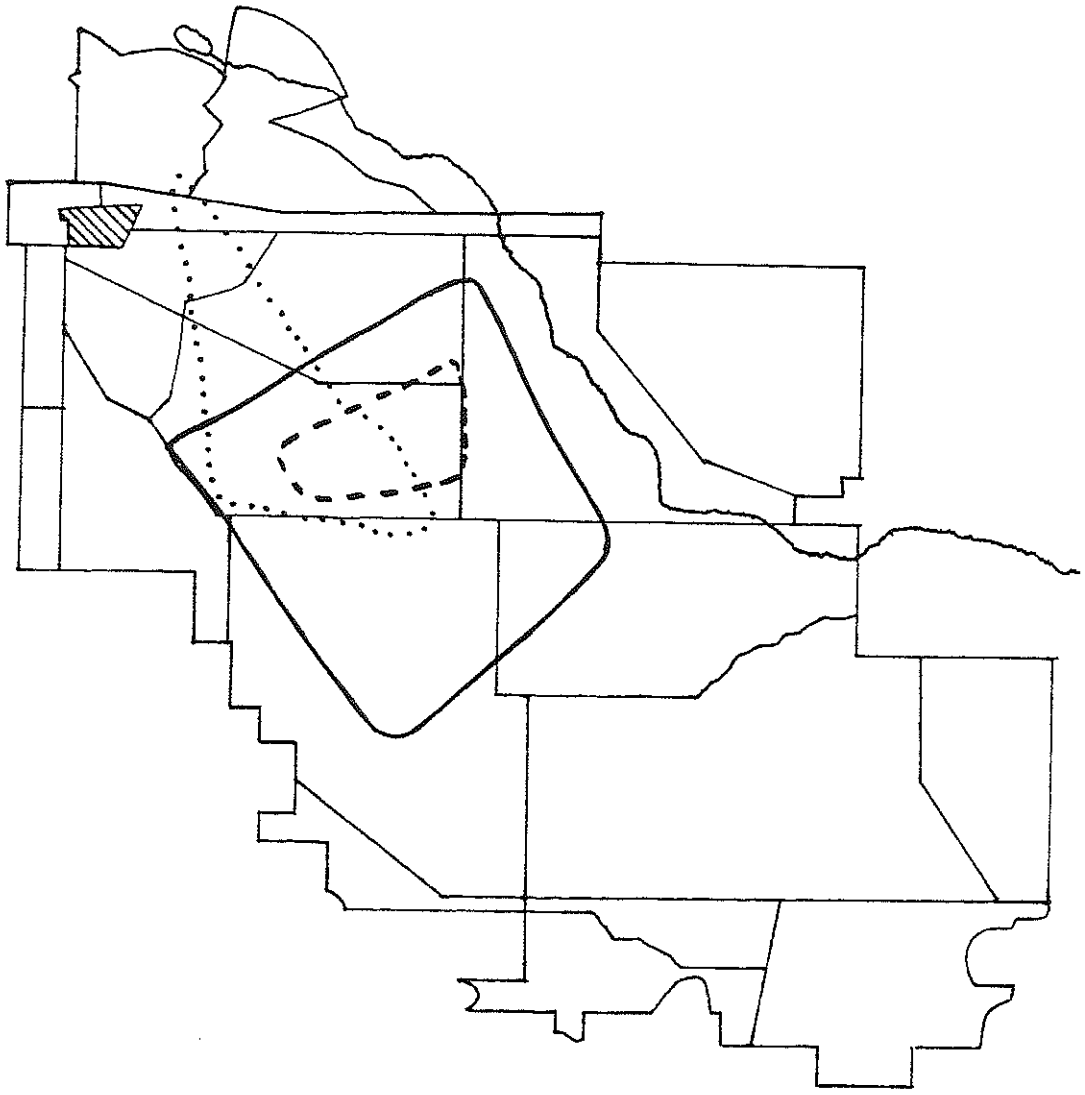


Figure 15. Seasonal ranges of elk 1683.

——— spring

------ summer

..... fall

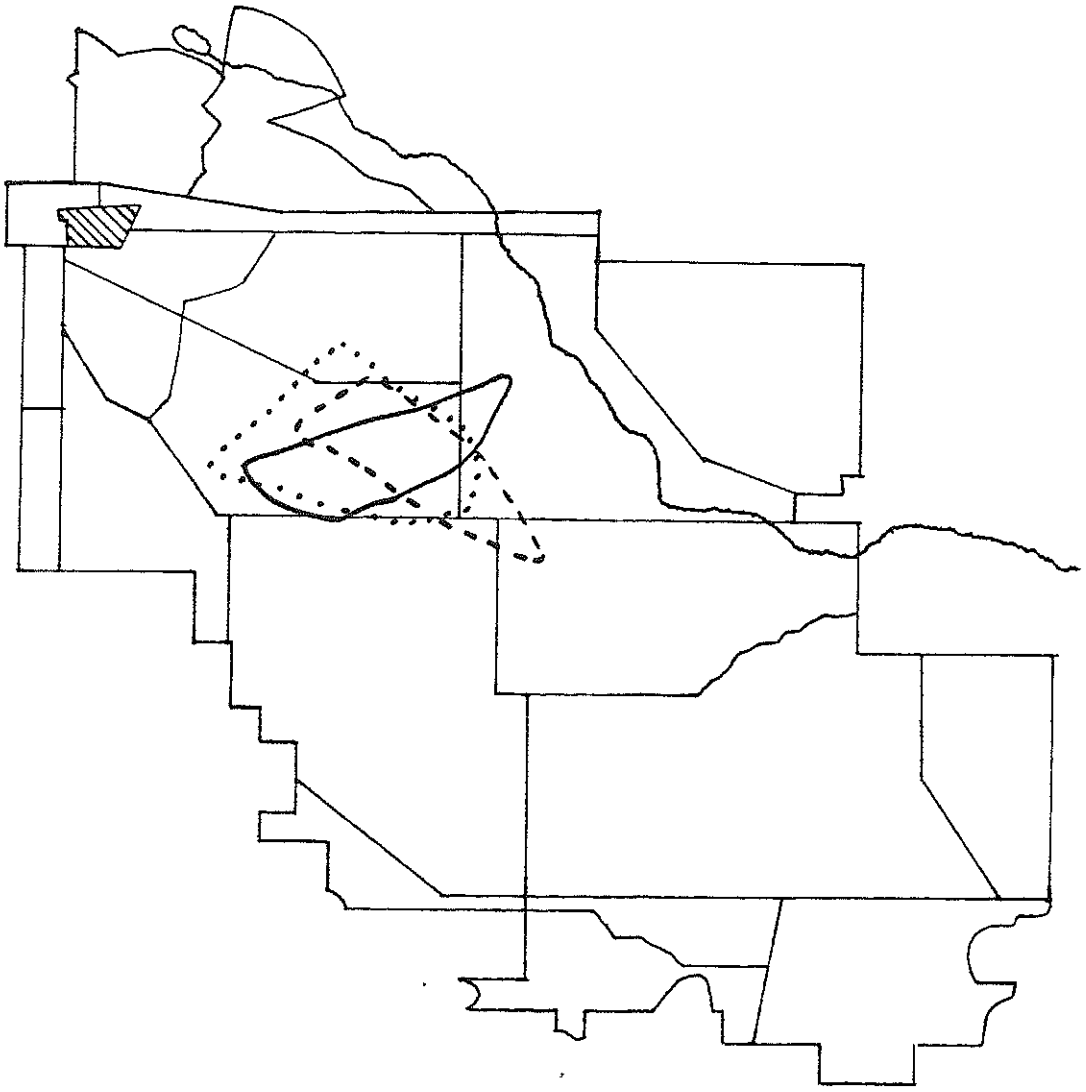


Figure 16. Summer range of elk 1685 during 1979 and 1980.

□ 1979

\+ 1980

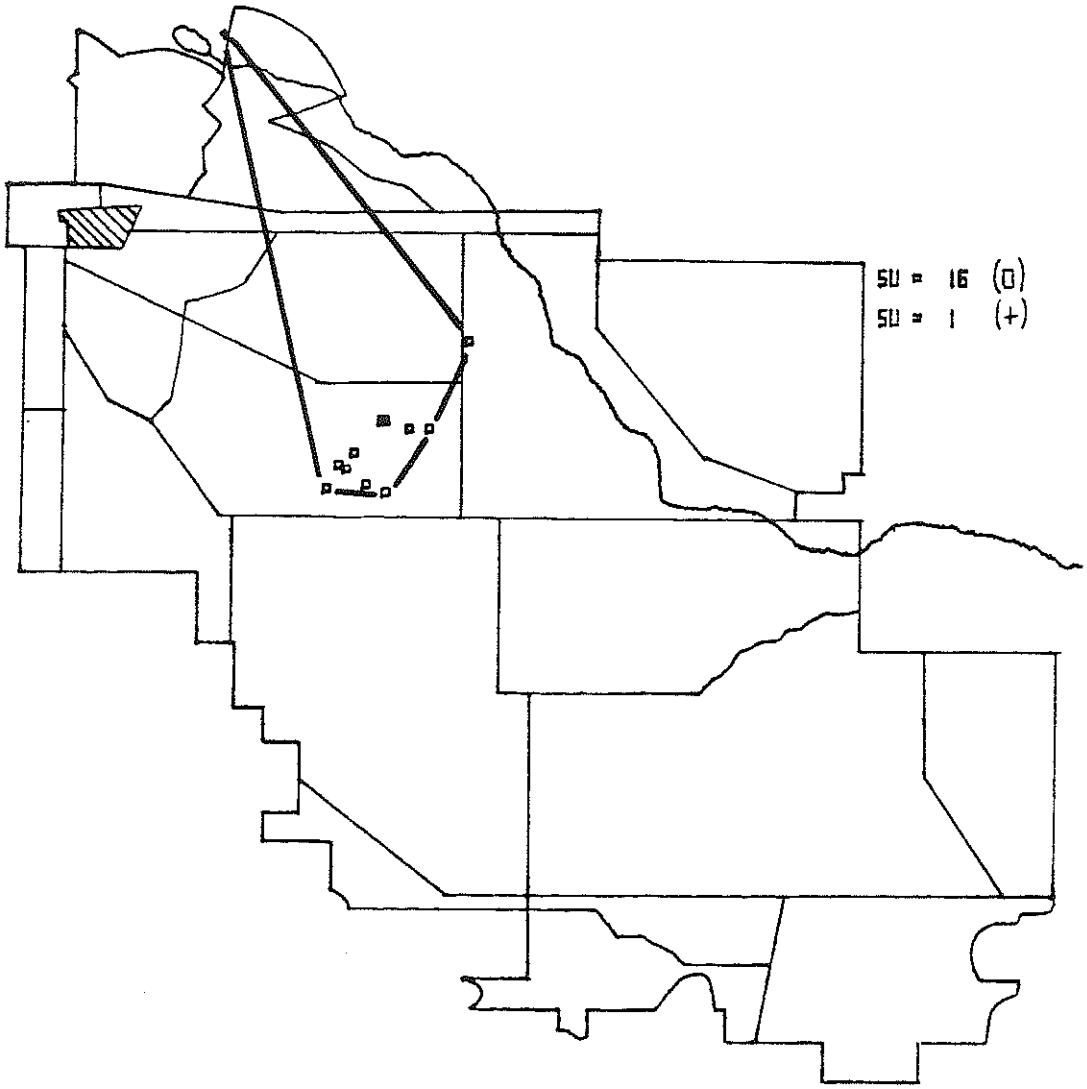
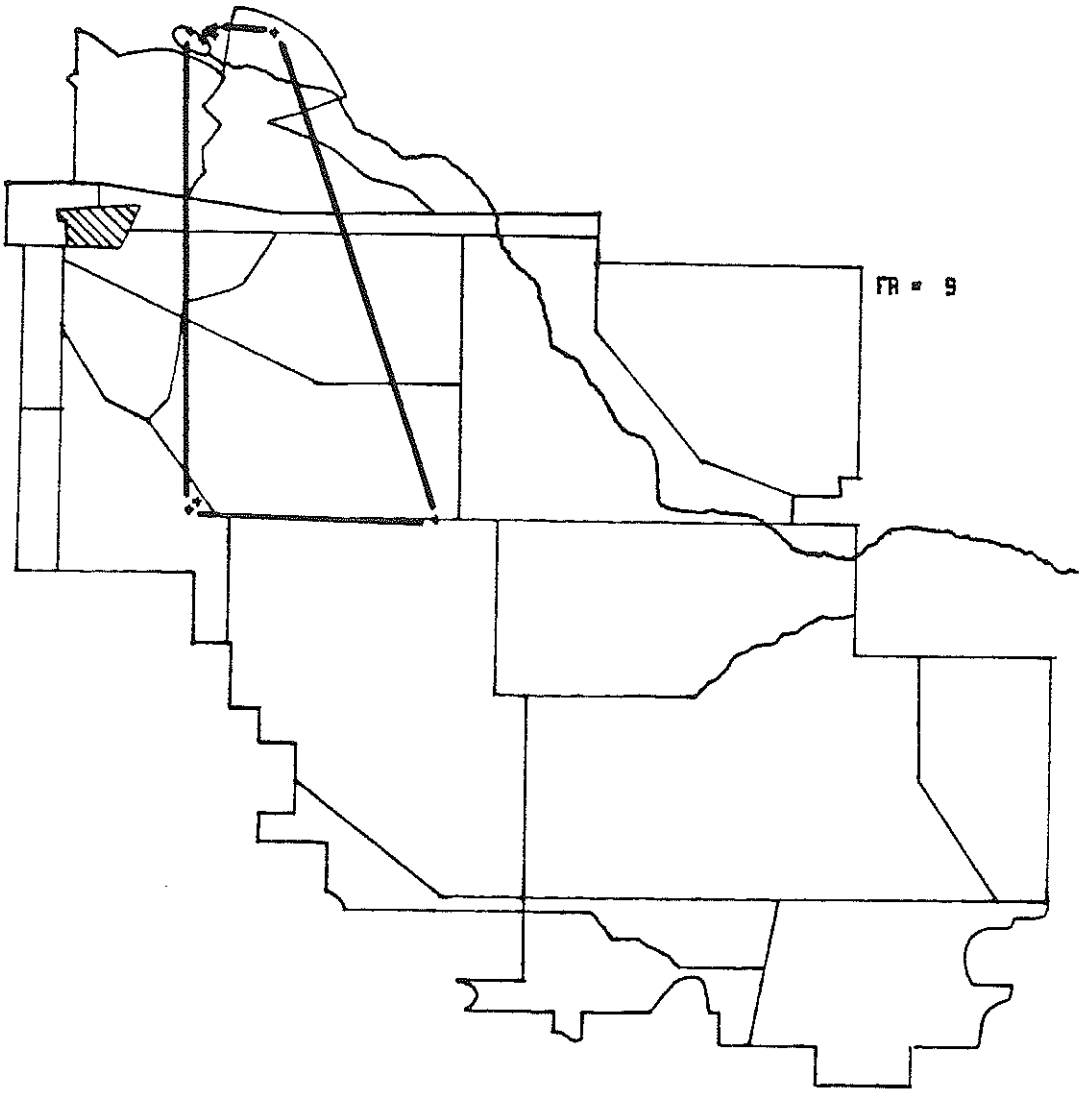

SU = 16 (□)
SU = 1 (+)

Figure 17. Fall range of elk 1685 during 1980.


FR = 9

The spring, summer and fall ranges of elk 1099 were generally confined to the area south of Epinette Creek (Figs. 18 to 20). During spring and summer, elk 1099 had an activity centre in the north-central portion of Zone I. The area contains a mixture of steep-sided hills and flat-bottomed valleys with open grassland on both the east and west sides. The area was traversed on foot and on horseback, but no water source was located. The presence of solitary spruce trees, the occasional clump of spruce and scattered aspen groves may provide shade, particularly on north and northeast slopes, making the area attractive during the summer months. Elk 1099 was relocated during the winter months, north of Epinette Creek in willow and aspen cover, and was the only elk to exhibit any seasonal preference.

Elk 680, the only other female trapped on the west side of the Reserve, did not use the same range as 1099 during the fall of 1980. Elk 680 remained north of Epinette Creek (Fig. 21). The only 1979 fall relocation for elk 1099 was also north of Epinette Creek.

The Spruce Woods elk population is non-migratory. Elk remain on the Reserve throughout the year. Hornbeck (1979) found that elk in the Spruce Woods Provincial Park move, in general, short distances between summer and winter range with some of the seasonally used areas being adjacent.

Movement of instrumented elk was highly individualistic. More extensive movements and greater use of available habitat seemed more prevalent in younger elk. This may be a sign of dispersal due to an increase in population. Individual associations were erratic; there was no evidence of regular or long-term associations (Table 6). Subsequent relocations of pairs of elk not trapped together were also random and

Figure 18. Spring range of elk 1099 during 1979 and 1980.

□ 1979

\+ 1980

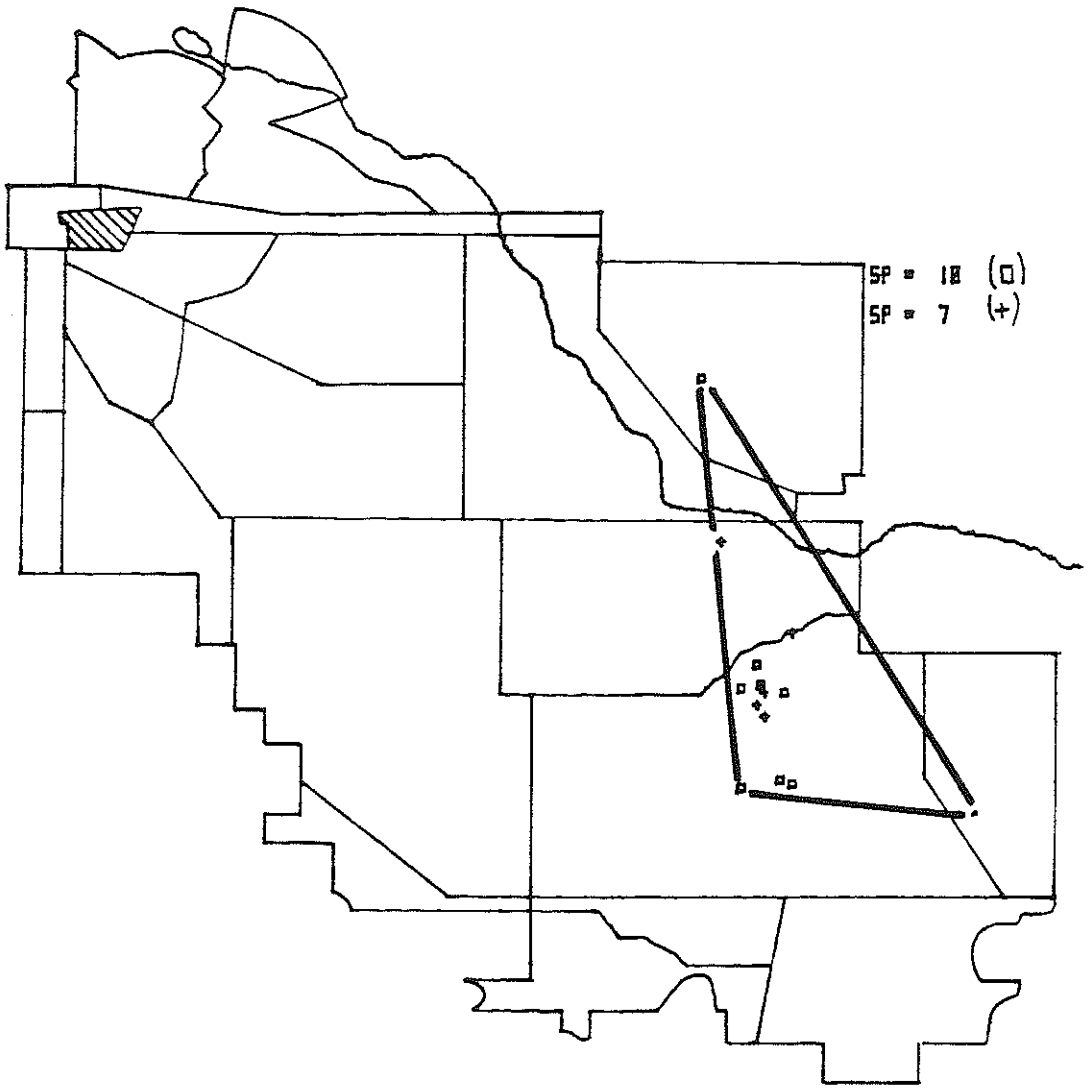

SP = 18 (□)
SP = 7 (+)

Figure 19. Summer range of elk 1099 during 1979 and 1980.

□ 1979

\+ 1980

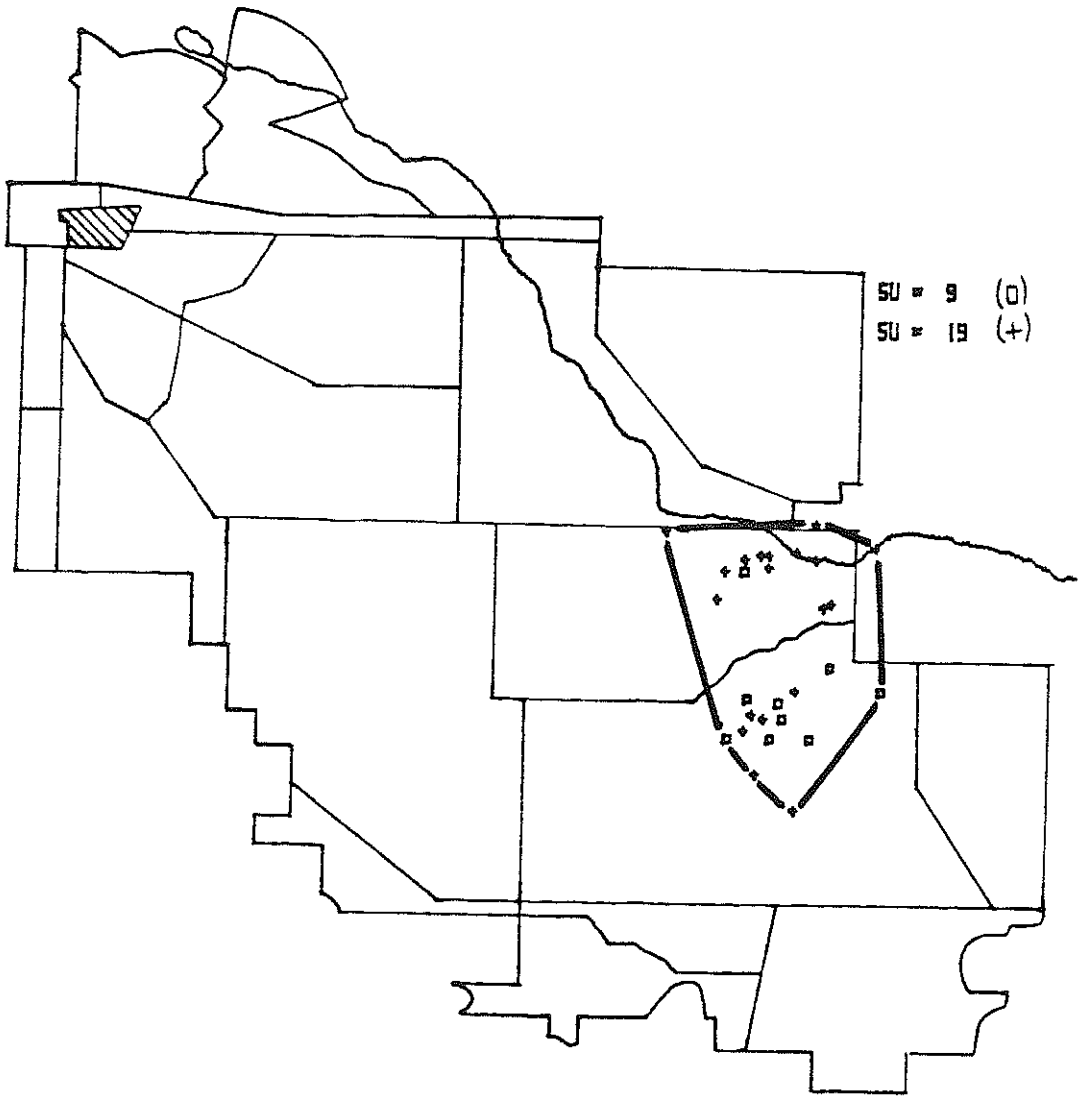

SU = 9 (0)
SU = 19 (+)

Figure 20. Fall range of elk 1099 during 1979 and 1980.

□ 1979

\+ 1980

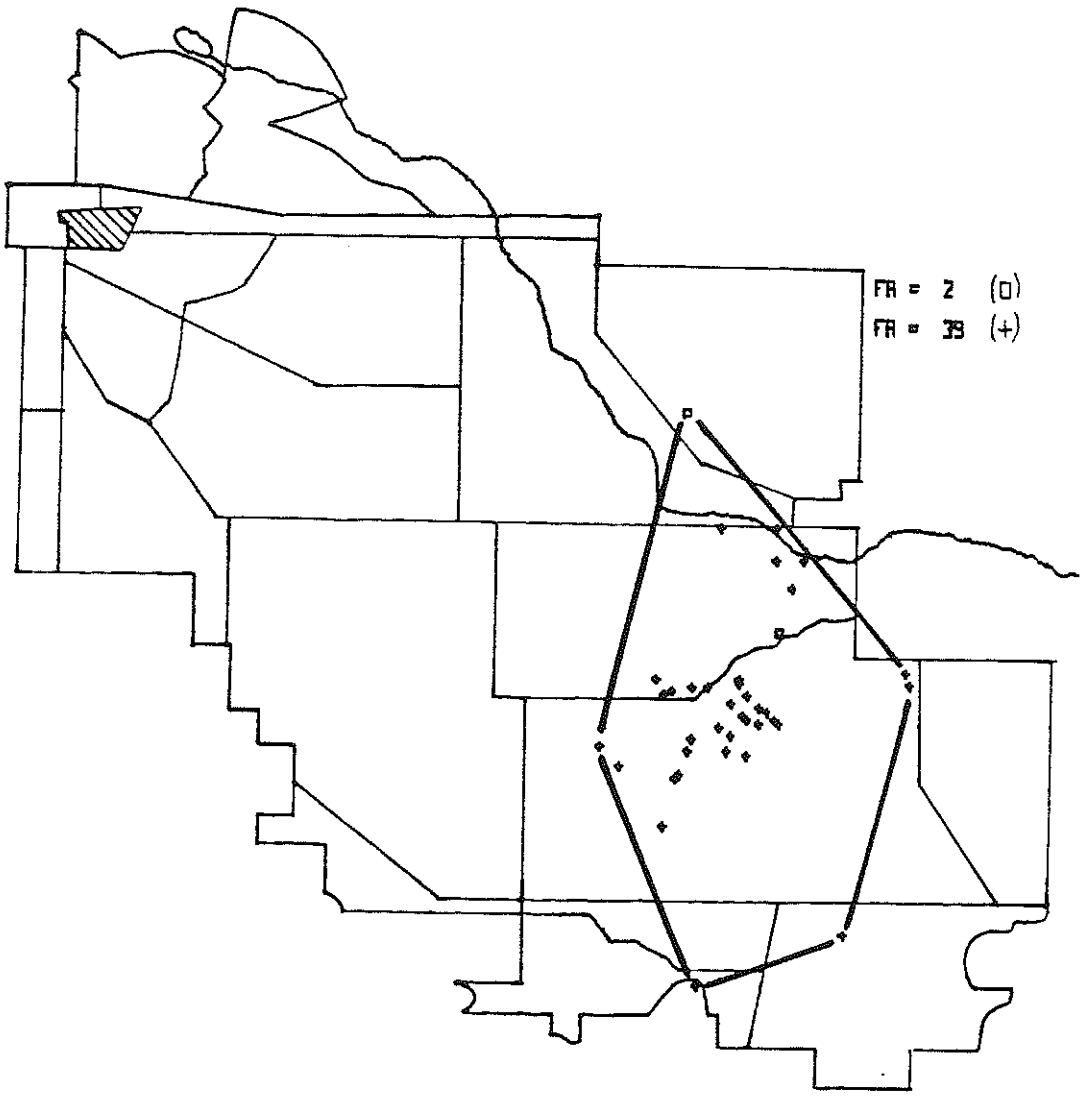

FR = 2 (□)
FR = 33 (+)

Figure 21. Fall range of elk 680 during 1980.

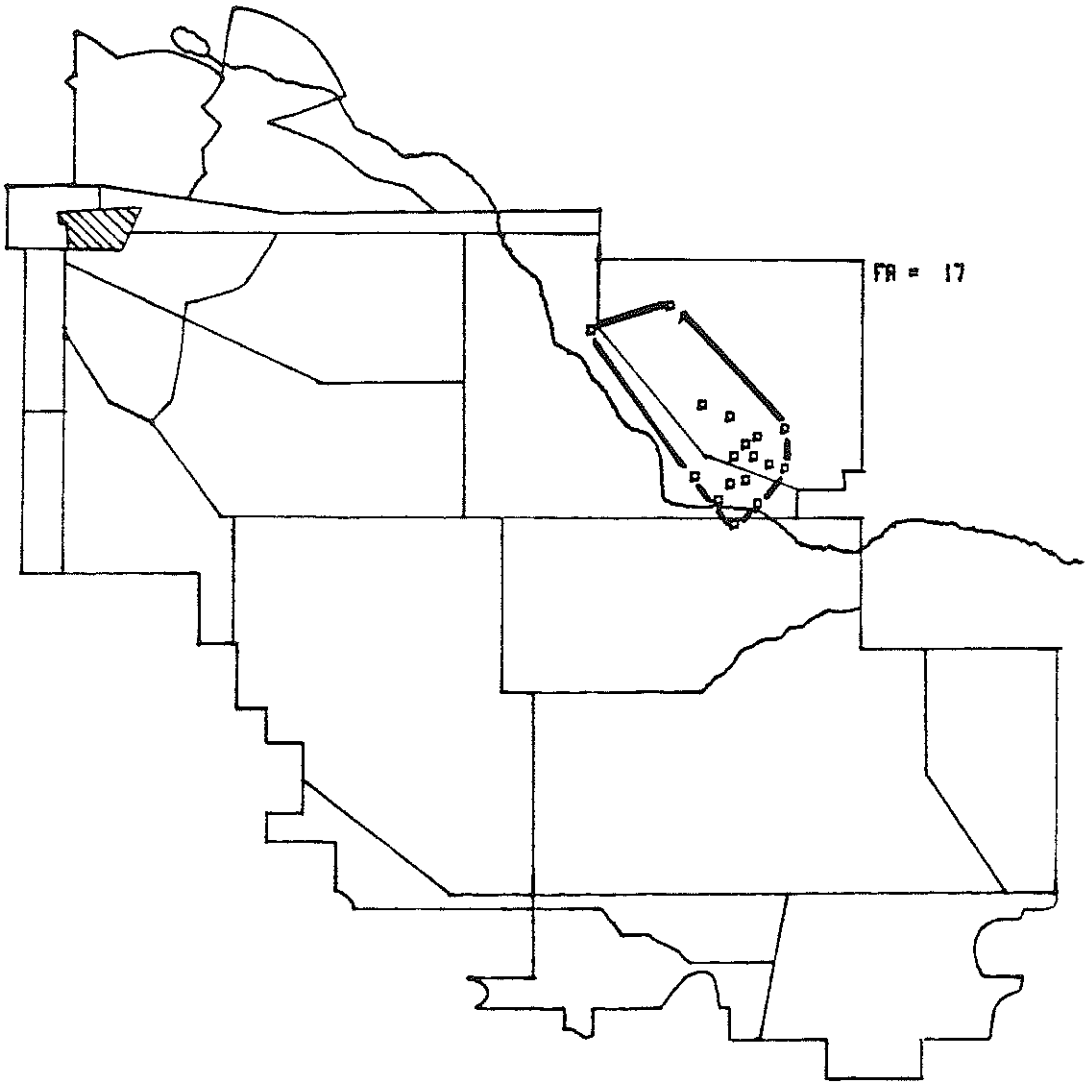

FR = 17

TABLE 6

Association of radio-collared elk trapped together and subsequently relocated

Trapping date	Number of elk trapped together	Possible pairings	Total subsequent relocations	Number of pairs located
30-i-79	4	6	101	2
2-ii-79	7	21	164	3
22-ii-79	4	6	108	0
27-ii-79	4	6	184	2
1-iii-79	2	1	92	0

erratic. The seasonal ranges of elk trapped together show general use of the same area, but patterns of use and movements are individualistic. Individuality of seasonal movements has been reported by Knight (1970) and Shoesmith (1979).

Spring movements of elk were more extensive than those noted during summer. This is likely a function of a general movement in search of new plant growth. Elk 1695 was sighted at Boxer on May 5, 1979. She had been in this general vicinity since early April, having moved east from the Trap 4 area. In June, elk 1695 had moved west to the vicinity of the dugouts and she remained there for the summer.

Movement over a greater distance during spring was found to be more common to younger elk in the female groups. This behaviour may indicate some displacement of younger animals, although non-instrumented adult females were known to be in the same general area. The eastward movement of elk from Trap 4, with subsequent return to the western portion of the Reserve, points out once more the importance of Zones H and 8 as "common areas" where elk from different segments of the population come together.

Spring movements were more erratic than those of summer. Spring movements were generally confined to that portion of the Reserve already delineated as winter range for the Trap 4 elk. Elk 1099, whose range is on the eastern portion of the Reserve, moved south of Epinette Creek during the spring and remained there.

Summer movements were more restricted and more predictable for all elk on the Reserve. Movements in the vicinity of the dugouts and across the ridge on the south boundary of Epinette Creek were noted throughout the summer. As mentioned previously, these movements are associated

with the presence of water. The reduced amount in the vicinity of the dugouts during the summer of 1980 is likely due to the reduction of available water due to the drought. The reduction of resting cover and shade near the dugouts also changed the movement pattern during the summer of 1980. Elk no longer moved to water and remained in the vicinity to rest and feed. Movement to the dugouts was from longer distances. The elk came to water and returned. Elk were less visible near the dugouts during the summer of 1980, but instrumented elk were not generally located in other portions of the Reserve. Elk 1685 was an exception to this. This elk, a young female, moved to the Sewell Lake area for the summer of 1980. It did not appear that a large number of elk frequented the Sewell Lake area during the summer months. Elk 1685 seemed to be alone and may have remained in the vicinity of water and food after having been displaced by the spring fires.

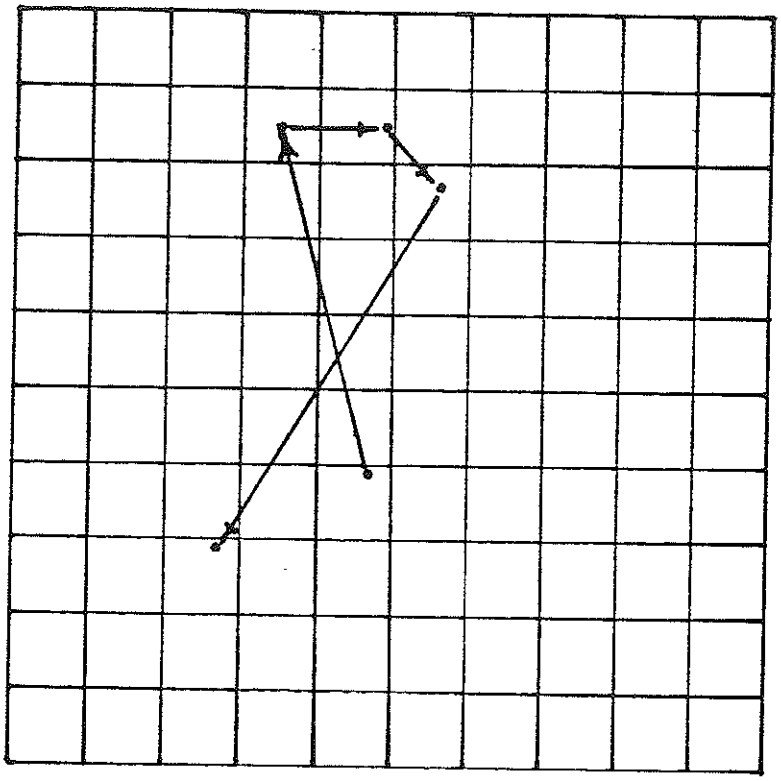
It was very difficult to draw comparisons between the summers of 1979 and 1980 due to the influence of the 1980 fires and drought.

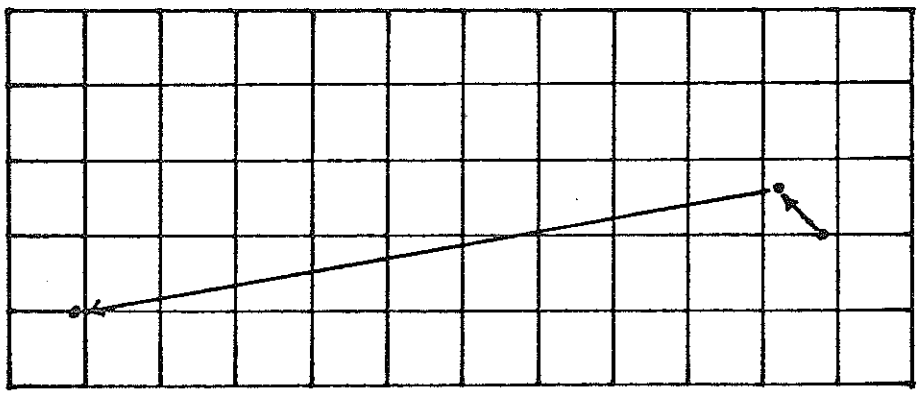
The erratic movements associated with the rut are reflected in the fall ranges of the instrumented elk (Appendix C). Elk began to show a general restlessness during the later half of August. Elk were usually seen moving at this time rather than grazing or bedding as had been the case during the summer. Herding behaviour was observed near the dugouts on September 2. Bugling had been heard earlier, on August 26, in the same vicinity when a large bull (not the one observed on September 2) was seen standing with four cows.

Movement in excess of 10 km within a 48-hour period was recorded for elk 1099 (Fig. 22) and elk 1633 (Fig. 23). Maximum distance between any two relocations were: adult female 17 km, adult male 12 km, yearling

Figure 22. Movement of elk 1099, September 1 to 3, 1980 shown on a 1-km grid.

Figure 23. Movement of elk 1633, September 13 to 14, 1980 shown on a 1-km grid.





female 12 km and yearling male 14 km. These figures correspond roughly to those determined for non-migratory elk in Montana (Mackie 1970).

During October 1980, elk 1685 left the vicinity of Sewell Lake where she had remained during the summer and early fall and moved south to the Aachen battle run. Elk 1695 moved from the dugout area, where she spent the summer, into the north portion of Zone B just south of Sewell Lake. Elk 1633 moved from Zone 8 south into the central portion of Zone I and back again. The actions of 1685 and 1695 may indicate movement onto winter range, or may be the result of rutting activity. Elk 1633, a bull, was disturbed in Zone I by an observer and promptly returned to Zone 8. He may have been in search of cows as large numbers of elk had congregated in the north-central part of Zone I at that time. Military personnel report large numbers of elk in this vicinity every fall (Captain W. Gordon, pers. comm.). It is apparently a centre of activity during the rut.

Elk on the Reserve did not conform to the generally accepted pattern of elk movement consisting of restricted movement in winter and summer, extensive movement in spring and erratic movement during fall. Winter movements for some elk were found to be the most extensive overall.

Hornbeck (1979) stated that the winter movements of Spruce Woods elk are restricted. Several factors may account for this apparent contradiction. Hornbeck dealt with a small number of elk and individuality of movement could account for different seasonal patterns. The habitat in the Park, where Hornbeck's work was concentrated, has a higher percentage of forest cover than the Reserve. The elk may behave in a different manner on the Reserve; large cow-calf groups were more

commonly seen there during aerial surveys. Perhaps the most important factor in accounting for the difference in winter movement is the difference in snow depths during the studies. Hornbeck (1979) reported snow depths in some areas of 127 cm. This depth was reported to be a drift and thus not representative of snow depths throughout the study area, but snow depths would likely approach 75-100 cm over much of the Park area. Since elk begin to be affected by reduced mobility after 75 cm depending on snow conditions (Gaffney 1941), it is conceivable that winter ranges were restricted. The extreme clemency of the winters during this study have already been discussed. The lack of snow depths approaching critical threshold in 1979-80 may have allowed elk to graze more during the winter season than during period years. The extensive winter movements may reflect a need to cover a larger area to obtain forage. Elk remaining on grassland would have to cover a wider area than elk wintering in a treed area and utilizing large amounts of browse.

The majority of instrumented elk on the western half of the Reserve exhibited regular movements toward and away from the dugouts in Zone E. These dugouts are at the centre of a radiating pattern of well-defined game trails, indicating regular usage over an extended period. Game trails crossing the ridge on the south side of Epinette Creek also showed regular use and were well-defined. Groups of elk were often seen during spring and summer travelling north or south in the vicinity of the ridge (Boyd 1978). The importance of the dugouts and Epinette Creek and associated swamp is shown by regularity of use.

The dugouts in Zone E are activity centres in a preferred area, judged by the number of relocations in their vicinity. Disproportionate

use of available habitat indicates preference (Waldrip and Shaw 1979). Elk may have used the dugouts less frequently during 1980. Signals were obtained or elk were observed on 19 of 20 visits during the summer of 1979. During the summer of 1980, no elk were visible or no signals were received on 7 of 22 visits. Large groups of elk were observed regularly in the vicinity during 1979, but not during 1980. In 1980 the dugouts dried up for approximately 10 days, and the amount of resting cover and shade in the area was greatly reduced by fire. The reduced amount of water and cover may have altered elk distribution during 1980.

Water is an important factor in elk distribution and movement. Boyd (1978) notes that water is present on all elk habitat in North America although some water can be obtained from vegetation. Elk distribution on the Reserve could be altered by the creation of artifical water sources in other areas. Mackie (1970) noted that elk were seldom found more than 1-1/2 miles (2.4 km) from a water source. Water was cited as a factor which made the treeless, shrub-steppe region of Washington suitable for elk habitat (Rickard *et al.* 1977).

Movement of elk during 1980 may have been affected by the spring fires, but this could not be determined. Elk 680, 1669, 1676, 1677, 1692, 1686 and 1688 were not relocated during the summer of 1980 and may have moved off the Reserve. Elk 680 and 1686 were located on the Reserve during the fall of 1980. Their radio transmitters were still functioning. Elk 1681 was shot in the Park during November 1979. The last contact with this bull had been May 5, 1979 in the north portion of Zone I. This bull was not relocated on the Reserve, or in the Park during the intervening period.

The findings of Hornbeck (1979) and of this study are inconclusive regarding the movement of bull elk. Some male elk apparently moved beyond the confines of the Reserve and Park, and some apparently did not. Movements of bull elk are far more extensive than for cow elk, and bulls may regularly remain east and north of the Reserve. Elk 1676 (a male) used different winter ranges during 1978-79 when he was in his first winter and 1979-80 when he was a yearling (Fig. 24). This eastward movement supports a bull range east of the range occupied by the cow-calf groups.

5.3 ELK USE OF ZONES 8 AND H

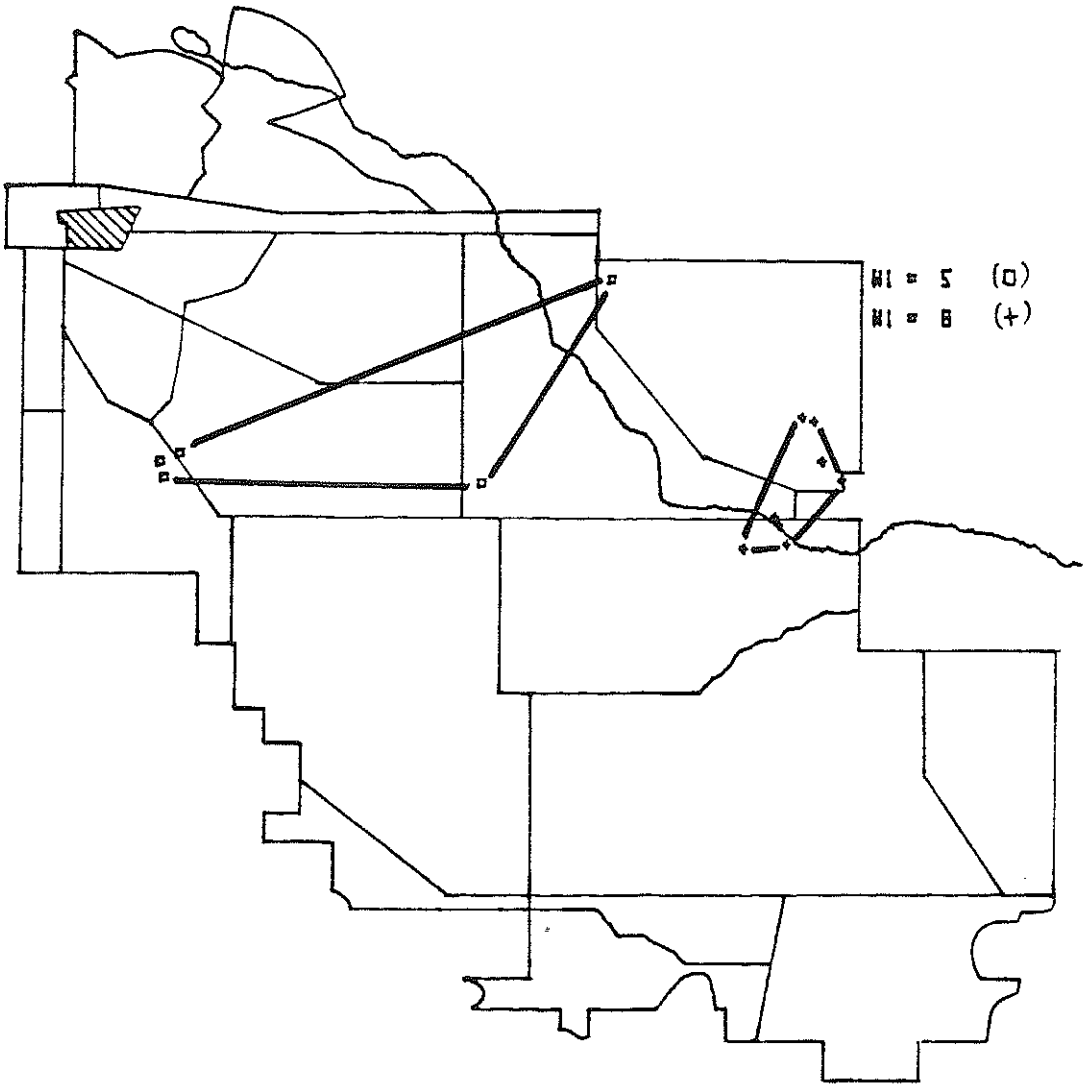
Zones 8 and H, except for the most northerly segment of the Epinette Creek swamp, are used by elk during all seasons of the year. The northern portion of the swamp is very wet and may make travelling more difficult during spring and summer. The census surveys flown in January (Figs. 5, 6 and 8) indicate that this portion of the Reserve provides winter range for a number of elk. Elk 680, 1099, 1633, 1669, 1681, 1696 and 1697 used Zones 8 and H as winter range during at least one winter. Bull elk 1633, 1696 and 1697 used Zones 8 and H as summer range. Elk 1633 remained in the area during the rutting period. The seasonal ranges of elk 1099 include portions of both Zones 8 and H. This elk has used essentially the same range for two successive years.

Hornbeck (1979) shows Zones 8 and H as part of the winter and spring range of a male calf elk during 1977-78, and as part of the winter range of a cow elk during 1978. The range of the calf elk was very similar to that of elk 1099. This similarity is further evidence

Figure 24. Winter range of bull elk 1676 showing the separation between calf-yearling and adult ranges.

□ 1979

\+ 1980


WI = 5 (□)
WI = 8 (+)

for the existence of a herd frequenting the east side of the Reserve, unless by chance the calf was an offspring of elk 1099.

Elk moved into Zones 8 and H between January and March 1979. During aerial surveys in January 1979, two adult bulls and one yearling bull were the only elk observed in those zones (Fig. 6). Later that year in March, one yearling bull, 17 adult bulls and 52 cows and calves were observed in Zones 8 and H (Fig. 7). The total number of elk counted during these surveys was 412 elk in January and 287 elk in March. In addition to the shift towards Zones 8 and H, 125 elk apparently left the Reserve during this period. This movement, occurring late in the winter, may indicate movement into areas where food was more readily available. Since elk were known to be wintering earlier on the open grasslands and adjacent brushy areas, it is possible that available forage was reduced. Snow depths in 1978-79 were greater than in 1979-80. Mid-thigh depths (75 cm) were common in Zone 8 in January. Heavy snowfall during January may have increased snow depths on the grassland areas beyond that at which foraging for grass is energy-efficient and mobility is only slightly impeded. This would also result in a movement to areas where food was available in larger quantities. Zones 8 and H, as well as the adjacent land to the north and east, has a high percentage of browse. It is also possible that the movement resulted, in part, because of the greater amount of cover available, but this seems unlikely since elk movements are not influenced to any degree by cold (Murie 1951, Boyd 1978).

The results of track counts carried out on the fireguard which forms the eastern boundary of Zone 8 are given in Table 7. The bulk of the crossings recorded occurred on the southern half of the transect.

TABLE 7

Track counts on eastern boundary of Zone 8 (L-R = eastward off Reserve)

Date	Km counted	Count period (days)	Tracks counted L-R	Tracks counted R-L	Tracks/km/day L-R	Tracks/km/day R-L
May 13, 1980	5	6	10	9	0.33	0.30
May 22, 1980	5	8	4	2	0.10	0.05
May 27, 1980	5	4	0	1	0	0.05
June 5, 1980	5	8	0	0	0	0
June 6, 1980	5	1	2	5	0.40	1.00
June 19, 1980	5	4	4	6	0.20	0.30
June 29, 1980	5	0.5	14	6	2.80	1.20
August 7, 1980	5	3	10	7	4.00	2.80
August 16, 1980	5	3	15	19	1.00	1.30
August 23, 1980	4	2	16	14	2.00	1.80

This may reflect the influence of agricultural crops in the immediate vicinity as elk were frequently sighted in flax and cornfields located adjacent to the Reserve boundary immediately south of Zone 8, particularly during August. The results of track counts carried out on the fireguard parallel with the ridge running from the southeast corner of Zone G through Trap G, Boxer and Pine are shown in Table 8. Table 9 gives the results of two track counts carried out in the vicinity of the dugouts. Fig. 25 shows the degree of use of each kilometer used in the computation of Table 8. Elk crossings were more frequent between Boxer and Pine.

Tables 7 and 8 show that during May and June access to and from Zones 8 and H was greatest along the southern boundary. Crossings on the southern boundary involved elk using other zones on the Reserve as part of their range, and the greater number of crossings is due in part to the larger numbers of elk on the Reserve. Elk moving north and south across the ridge were noted on many occasions and the bulk of this movement is attributed to regular movement to a water source. Game trails crossing the ridge are well-defined and show many seasons of use. During 1979, water was available immediately adjacent to the ridge, and the major trails showed use each time they were checked ($n = 22$). The number of elk crossing the fireguard associated with the ridge (exclusive of game trails) increased in August 1979. This propensity for greater movement was also noted in other areas and was attributed to behaviour associated with the approaching rut. At this time elk began to move away from the waterhole more frequently and for longer periods.

A comparison of Tables 8 and 9 shows that the dugouts were being

TABLE 8

Track counts along ridge in south portion of Zone H
(L-R = north along Epinette Creek)

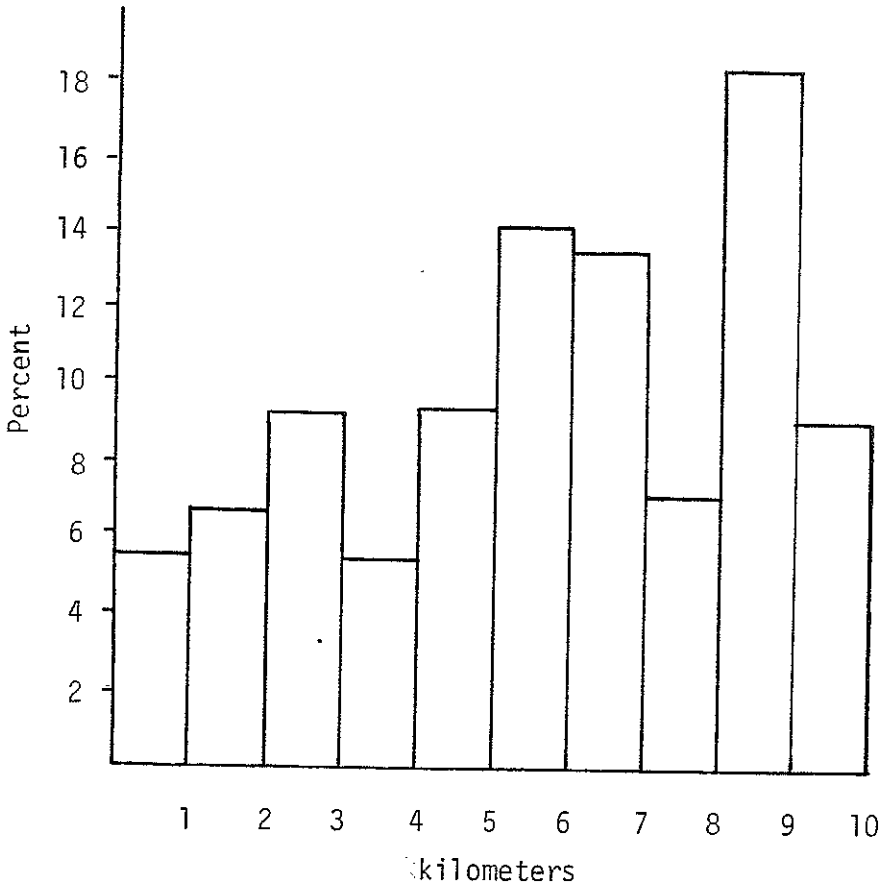
Date	Km counted	Count period (days)	Tracks counted L-R	Tracks counted R-L	Tracks/km/day L-R	Tracks/km/day R-L
May 24, 1980	10	6	48	54	0.8	0.9
May 28, 1980	5	2	15	17	1.5	1.7
June 5, 1980	5	1	16	21	3.2	4.2
June 10, 1980	10	4	125	114	3.1	2.9
June 14, 1980	7	1	12	24	1.7	3.4

TABLE 9

Track counts in the vicinity of the dugouts
(L-R = north towards dugouts)

Date	Km counted	Count period (days)	Tracks counted L-R	Tracks counted R-L	Tracks/km/day L-R	Tracks/km/day R-L
May 11, 1980	3	8	56	64	2.3	2.7
June 14, 1980	3	1	31	41	10.3	13.7

Figure 25. Track counts along the Epinette Creek escarpment in the southern portion of Zone H. The percentages shown are averages of all crossings. Boxer is located at Km 5 and Pine at Km 10.


Percent
18
16
14
12
10
8
6
4
2
1
2
3
4
5
6
7
8
9
10
kilometers

used by a greater number of elk, or that elk in the vicinity were moving to water more often. Since elk can be expected to use similar amounts of water during any given period, movements in the dugout area are an indication of greater numbers of elk.

Elk often trail rather than move in a spread-out fashion, particularly in hilly terrain and through forest and bush. This made track counting very difficult since the number of animals passing could not be determined. Elk crossings of the ridge and in the vicinity of the dugouts are, in all likelihood, greater than indicated by the tables.

Bull elk, being more solitary than cows, may prefer more isolated habitat. Isolation can be obtained by moving to remote parts of the range, or by being secretive and remaining in the more-forested parts. Spruce Woods bull elk appear to have adopted the latter strategy since their preferred range is the more-heavily forested portions of the Reserve, Zones 8 and H, and the Park which has a high percentage of forest and contains more spruce than the Reserve. Zones 8 and H and the Park have not been subjected to the fires that regularly occur over most of the Reserve; the habitat reflects this.

5.4 RESPONSE TO DISTURBANCE

Disturbance of elk can be direct or indirect. Direct disturbance occurs when an elk is physically threatened or displaced. Examples of direct disturbance are: hunting, harassing by vehicular or pedestrian traffic and fire. Indirect disturbance, more difficult to ascertain, occurs when an action not directed at elk or elk habitat causes a

response in the elk. Examples of indirect disturbance are: the proximity of a townsite, the presence of a well-travelled road and artificial, but not necessarily detrimental, changes in habitat.

Observations of elk during this study did not indicate that disturbance by humans was a major influence on elk distribution and movement. Morgantini and Hudson (1979) concluded that winter elk distribution and activity was influenced significantly by human activity. Hayden-Wing (1979) reported winter concentrations of elk within those portions of the range farthest removed from human activity. Fig. 8 shows that elk on the Shilo Military Reserve utilized areas adjacent to high human-use areas as winter range. During the winter, elk are frequently seen along well-travelled roads south and east of the townsite of Shilo. The golf course, immediately east of the townsite, is used by elk during the winter. The distribution noted by Morgantini and Hudson (1979) and Hayden-Wing (1979) may reflect response to hunting pressure. Spruce Woods elk were not hunted, legally, prior to the fall of 1979 and may have developed responses to human activity different from those of a hunted population.

Elk response to an approaching human was noted on many occasions during this study. It was noted during the summer of 1979 that an observer on foot could move about in view of elk if movement was slow and not directly towards them. Cow groups exhibited nervousness, but did not often resort to flight when an observer was in view. Groups of elk were more likely to flee and to move greater distances if an adult bull was present. Altmann (1956) found that bull elk were less wary than females and calves. Approaching elk directly caused flight on every occasion, although the elk-to-observer distance which produced

flight varied greatly.

Elk response to vehicular traffic seemed to be a function of the speed and nearness of the vehicle. A rapidly moving vehicle or one moving directly towards elk caused movement, but not necessarily away from the vehicle. Elk often moved across the roadway in front of a vehicle, even though nothing prevented them from moving away from the road. Murie (1951) mentions the propensity for elk to keep an adopted course even if that course converges with the path of an approaching horse or vehicle. Vehicle traffic may disturb elk frequently as elk were often seen crossing a road or moving immediately after the passage of a vehicle.

Flight distance depended on the degree of disturbance. Elk which were directly harassed moved greater distances, usually out of sight, compared to elk which were merely disturbed. There was no evidence that elk avoided roads or fireguards.

Kuhn and Martens (1979) report concentrations of elk near developments, the use of drill hole seepages or mineral licks, the use of roads and powerline rights-of-way for travel, foraging on reclaimed land and increased use of restricted shooting zones. Summer concentration of elk in the vicinity of the dugouts, which are artificial water sources, is an example of range enhancement by human activity.

The effects of military activities, particularly those involving the use of live ammunition, on elk were difficult to assess due to restricted access to the Reserve. Moreover, the following excerpt from field notes taken during a helicopter flight on March 6, 1980 indicates an apparent lack of concern by elk in the vicinity:

> The two large groups of elk [30 and 34] were within 1 or 2 km of the impacts of the artillery fire. They were grazing and bedded down on the edge of a treed [aspen] area. 1678 was bedded down and was unconcerned as the helicopter slowly circled her [immediately after the cessation of firing]. We approached to force her to move, to see if she was capable of movement, and she got to her feet and slowly moved away.

The flight took place during midday and it was sunny and warm with very little wind.

Military activity can, for the most part, be categorized as indirect disturbance. Vehicular traffic is generally confined to existing trails or tank tracks and consists of point-to-point movement. The noise associated with a military artillery range is similar to the noise associated with a severe electrical storm. Access to the Reserve is restricted, even to military personnel, and casual or recreational activity is minimal. The presence of military personnel on the Reserve is associated with specific duties or military exercises and the free time required to explore or seek out and observe wildlife is virtually non-existent. Elk may, on occasion, be pursued or otherwise harassed by military personnel and reports that harassment sometimes results in the death of an animal cannot be discounted, but there is no evidence to suggest the elk population is subjected to continual direct harassment.

Elk likely avoid battle run areas when tank training is in progress, and similarly likely avoid any area where there is extensive human activity. However, they do not habitually avoid these areas. Elk were sighted grazing and resting on battle runs and in impact areas when they were not in use, on one occasion within an hour of the cessation of training.

Training "noise" is unlikely to affect elk to any great extent.

The frequency of tank and artillery shelling and of vehicle noises on the Reserve allows animals, including elk, to habituate. Deer were observed feeding close to a firing point, and livestock from the Forest Hill Ranch did not react to distant artillery fire. Observations of elk response to artillery fire, discussed earlier, also showed a lack of reaction. The sound of artillery fire resembles thunder.

Direct disturbance of elk by military activity occurs when habitat is rendered useless for an extended period. Continued use of an area by wheeled and tracked vehicles removes the vegetation from the soil, making the land useless to elk. Approximately 50 km^2 presently fall within this category in the form of roads, battle runs, fireguards, tank tracks and built-up areas. These land-use practices result in areas of perpetual "non-habitat" but the overall effect of their presence is reduced since they are dispersed throughout the Reserve. Any major increase of the area consumed by these practices would be detrimental to the overall welfare of the elk populations because of the removal of available habitat. This has been realized, and an investigation of the potential for revegetation of denuded areas is currently in progress.

A very important aspect of military activity on the Reserve is the regular occurrence of range fires caused by the impacts of some types of live ammunition. During most years, the areas burned are small, seldom exceeding 5 ha, and scattered over the Reserve. The physical threat of fire is a direct disturbance, but it is short-term. The regrowth of vegetation after a fire may affect elk distribution. New growth is tender and more palatable. Elk in Riding Mountain prefer recently burned areas (Blood 1966). In some parts of North America, land is burned to create elk habitat (Leege 1969, Leege and Fultz 1972).

Major fires on the Reserve are an irregular occurrence. During the extremely dry spring of 1980, several major fires occurred and almost the entire Reserve was burned-over. In some localities the fire moved quickly and consumed only dry grass and litter; in others, groves of aspen and spruce were burned and the ground cover virtually destroyed.

The effects of the 1980 fires on elk movements and distribution are hard to assess for several reasons. Firstly, the fires occurred during a severe drought which continued through most of the summer. Distribution and movements which may have been due to the fires could not be isolated from distribution and movements due to the drought. Secondly, military use of the Reserve was more intensive during the summer of 1980 than during the previous summer. Periods of access to the Reserve were of shorter duration and occurred less often. A third reason is the greater emphasis placed on the eastern half of the Reserve during data collecting activities in 1980. This change in emphasis was due in part to the presence of instrumented elk in Zones 8 and H during the 1980 summer season, and in part to the emphasis placed on observing access to those same zones by regularly checking the perimeter to monitor ingress and egress via game trails and incidental crossings.

Elk may be disturbed to a greater degree by different military activities. The bulk of the daytime training on the Reserve during the summer months involved the armed forces of the Federal Republic of Germany. Use of the Reserve by the West German armed forces consisted of tank and similar weapon training on the battle runs. This type of training results in essentially unidirectional firing and rather restricted impact areas. Elk could habituate to this type of training

and utilize a considerable portion of the Reserve during training, due to the constant nature of the firing and impact areas.

Military training involving random and omnidirectional firing results in erratic impacts and could conceivably be far more detrimental to elk. Much of the training of the Canadian armed forces falls into this latter category. It was noted that elk appeared to move to the perimeter of the Reserve when the Canadian armed forces began to occupy the daylight training hours after the West German forces had concluded their 1980 use of the Reserve (K. Rebizant, pers. comm.). This movement may have been due, at least in part, to the change in the type of military use, but it occurred during the rutting period and may simply reflect normal movement at that time.

Elk on the Reserve were more secretive during the summer of 1980 than during the summer of 1979. Fewer elk were observed grazing in the areas they had habitually used the previous year. Elk use of the dugout area in 1980 was reduced from 1979. This apparent difference in distribution may have resulted, in part, from the extended daily training schedule of 1980, since evening use often involved omnidirectional firing. The effects of fire and drought could also have caused such behaviour, however, and the transmitters of four cow elk from that portion of the Reserve may not have been operational during the second summer.

The differential distribution discussed earlier and the eastward movement of bulls is likely an inherent trait, and cannot be attributed to military activity.

5.5 RECREATION POTENTIAL OF SPRUCE WOODS ELK

The Spruce Woods elk population has potential for both consumptive and non-consumptive recreation. The Reserve will play an important role in elk management programs since it is important elk habitat. The majority of the Spruce Woods elk population utilize the Reserve.

Consumptive use of Spruce Woods elk (hunting) was initiated in the fall of 1979. To date, the program appears successful (L. Bidlake, pers. comm.). Restricted access to the Reserve does, however, present difficulties for the elk manager. The Reserve is open to the public, with permission from C.F.B. Shilo, only during the late or November hunting season. In light of data indicating that the majority of the male segment of the population frequents range outside the confines of the Reserve, this may result in a higher-than-expected take of males. This would result even if hunters were allowed to take either sex due to the greater percentage of bulls in the segment of the population outside the Reserve and the vulnerability of bulls during the rutting period.

Boyd and Lipscomp (1976) showed that, by protection of young bulls, the harvest of trophy bulls could be increased. This could only be achieved, however, by a substantial decrease in the total harvest. Management for trophy bulls does not appear to be a sound method of population manipulation if reduction of overall numbers is necessary. Trophy seasons will, however, provide some consumptive recreation and at the same time allow population numbers to increase.

The findings of Prothero *et al.* (1979) regarding the different dynamics resultant from adult or yearling bulls acting as breeders

have already been discussed. The potential for an increase in calf mortality when yearling bulls are acting as breeders must be considered in planning. Prothero *et al.* (1979) do point out, however, that mature bulls do not seem to be important in the short-term behavioural welfare of cow-calf groups. They also point out that the selective pressures that induce the morphological and behavioural characteristics of dominant bulls would not be operating if yearlings were acting as breeders. Yearling bulls would introduce genetic variability to the population. The authors speculate that genetic variability could be of great value to elk in adapting to changing habitat. In addition, selection might favour earlier and more-efficient breeding activity by yearlings.

The choice of an "any elk", "any bull" or "trophy bull" season will therefore depend on the dynamics of the individual population and the ultimate aim of the elk manager.

Elk during the rutting period are more vulnerable to hunters than at other times. The fact that the majority of the elk spend this period on the Reserve reduces this vulnerability and tends to assist breeding by reducing disturbance and preventing bull deaths. Allowing access to the Reserve by elk hunters only during the latter stages of the rut should ensure that most cows have been bred. The only caution to be observed here is the ratio of yearling bulls acting as breeders. If this number is large, the late season could reduce breeding success.

The Reserve provides habitat for the majority of the Spruce Woods elk population and could serve as a reservoir from which surplus animals could move into the surrounding areas. Conflict with area landowners is likely to result from this phenomena, unless the surplus

elk tend to move into the Park and remain there. At the present time, the habitat in the Park does not seem to contain the mix of grassland and cover required by elk. Forest cover is greater in the Park compared to the Reserve, 95% to 52% according to Hornbeck (1979). For this reason, the numbers of elk in the Park will not likely increase substantially. The hunting which takes place outside the confines of the Reserve will take those elk which are surplus to the habitat on the Reserve.

Non-consumptive recreational uses of elk include viewing and photography. Both these pastimes occur outside the confines of the Reserve, but these activities are intermittent and elk are seldom seen with regularity unless they are feeding on crops. The Reserve is the only location where elk can be viewed with any amount of regularity. During the summer of 1979 a drive across the Reserve usually resulted in at least one sighting of elk. This is a function of the habitat. The Reserve provides good elk habitat and is also open enough to allow elk to be visible.

Zones H and 8 are similar in nature to the habitat in the Park. They do contain elk, but they are less visible. Viewing in Zones H and 8 would be possible during the late winter months but very difficult during the remainder of the year.

Elk do not appear to frequent the Bald Head Hills areas with any regularity. It is unlikely that tours in the area would encounter elk except by chance.

The problem is in management of elk and elk habitat rather than the presence of elk. If elk viewing is seen as an integral part of the potential of Spruce Woods Provincial Park, habitat management may be

required to provide the interspersion of forest and grassland that is characteristic of good elk habitat. The creation of grassland areas would in all probability increase the number of elk in the Park and would make viewing easier.

Use of elk by consumptive and non-consumptive users must be considered in long-range planning. The elk population must be examined so its requirements are known and the long-term development thrust of the Park must be known in order that the two can be integrated. The provision of hunting areas and refuges cannot be done on an *ad hoc* basis if the ultimate goal is integrated recreation. Planning will provide for future use of elk by both consumptive and non-consumptive users if the planners realize that compromises in land use and available recreation are necessary.

CONCLUSIONS

The apparent irruption of elk in the Spruce Woods occurred in the early 1970's. The elk population is presently in a state of stabilization. The arrival of the armed forces of the Federal Republic of Germany altered the land-use pattern on the Shilo Military Reserve and created habitat more suitable for elk.

Zones H and 8 provide habitat for some of the resident elk. Bull elk were found to frequent these zones regularly. These zones provided winter range, particularly during the latter months, for large numbers of elk. Elk use of Zones H and 8 may be due in part to the proximity of agricultural crops.

Calving by elk is not confined to the Epinette Creek area. Observations indicate that calving takes place on the spring range of the cow. There are no data to support any particular portion of the Reserve as a common calving area.

Elk remain on the Reserve throughout the year. The majority of the elk on the Reserve do not utilize specific seasonal ranges and no portion of the Reserve was used exclusively during one season.

Elk on the Reserve are clumped and distributed for the greater part of the year differentially by sex. Preference for the western portion of the Reserve was exhibited by females, and preference for the northeastern portion by adult males.

Elk activity centres do not necessarily contain water, but the dugouts in Zone E are a major activity centre for elk frequenting the western portion of the Reserve. Epinette Creek also serves as an important water source for elk.

The Spruce Woods elk population may contain herds with distinct home ranges. Data indicate the presence of a herd on the west side of the Reserve and another on the east side. There may also be a third herd in the southwest corner of the Reserve and the adjacent agricultural land. The ranges of the first two herds mentioned overlap in Zones H and 8.

The regular occurrence of fire on the Reserve has enhanced elk habitat and influences distribution and range use by altering habitat.

Elk respond differently to direct and indirect disturbance. Indirect disturbance of a non-hunted elk population is unlikely to cause movement or result in abnormal distribution. Military activity on the Reserve results, on most occasions, in indirect disturbance. Elk can habituate to training noise and to the use of specific locales. The distribution and movements of elk on the Reserve are primarily inherent. Military activities are important only in a local sense. Elk do not habitually avoid roads, fireguards and those portions of the Reserve that are high-use areas.

Military activities involving omnidirectional firing of live ammunition have the potential for direct disturbance and may influence elk more than activities involving unidirectional firing.

RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Based on available data, I recommend the following steps be taken:

(1) A master land-use plan for the Shilo Military Reserve should be prepared. This plan would provide for optimum use of the Reserve by military and by resident wildlife including elk. Firing points and specific locales for the impacts of artillery fire should be planned to consider the requirements of wildlife as well as those of the military. Management of habitat, in a broad sense, could be easily accomplished with a realignment of current military activities to meet predetermined goals. The master plan could, for example, suggest the creation of dugouts to meet the needs of both the military and the wildlife.

(2) The elk which are presently instrumented should be monitored as long as the transmitters are functioning. Preparation of a comprehensive elk management program for the Shilo Military Reserve requires data collection over an extended period. The importance of collecting as much data as possible cannot be underestimated.

(3) A study of the distribution and movements of bull elk in the region should be initiated as quickly as possible. Available data suggest that areas beyond the confines of the Reserve and the Park may be important as bull range.

(4) An investigation of the social behaviour of the Spruce Woods elk to provide information on the possible existence of discrete herds should be made. This investigation might also include an examination of the existence of habitat-induced social behaviour. Elk in the Park may have developed different social responses than those on the Reserve due to the closed nature of the Park habitat. Female elk in the Park may be more solitary during all seasons.

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APPENDICES

APPENDIX A

Elk live-trapped and radio-collared on the Shilo Military Reserve, 1978-1980
(age is denoted as: A = adult, Y = yearling, C = calf)

Elk number	Date of capture	Trap location by zone	Sex	Age	Collar colour	Frequency (MHZ)	Eartags Colour	Eartags Left	Eartags Right
680[a]	14-ii-80	8	F	A	purple	151.023	green/red	174 B	124 B
1099	1-iii-79	8	F	A	yellow	151.240	yellow	172 B	197 B
1633	11-iii-80	G	M	A	purple/white/green	151.200	blue/green	125 B	173 B
1641	27-ii-79	4	F	A	green/red block	151.402	yellow	193 B	194 B
1669	1-iii-79	8	M	Y	red	150.995	yellow	199 B	200 B
1676	2-ii-79	4	M	C	blue	150.880	white	90 A	91 A
1677	15-xii-78	4	M	C	yellow	150.891	yellow/blue	177	177
1678[b]	30-i-79	4	F	A	red	150.910	white	80 A	81 A
1679	22-ii-79	4	F	A	green/white block	150.972	yellow	184 B	185 B
1680	2-ii-79	4	F	C	purple	151.023	white	92 A	93 A
1681[c]	22-ii-79	8	M	Y	green/yellow block	151.140	yellow	179 B	178 B
1682	2-ii-79	4	F	Y	blue/white stripe	151.157	white	88 A	89 A
1683	22-ii-79	4	F	A	red/blue stripe	151.187	yellow	182 B	183 B
1684	21-ii-79	4	F	A	green/yellow stripe	151.199	yellow	174 B	171 B
1685	30-i-79	4	F	Y	red/white stripe	151.230	white	82 A	84 A
1686	2-ii-79	4	F	A	purple/white stripe	151.246	white	98 A	100 A
1687	27-ii-79	4	F	A	yellow/white stripe	151.260	yellow	188 B	189 B
1688	2-ii-79	4	F	C	green	151.278	white	94 A	95 A

. . . continued

APPENDIX A (continued)

Elk number	Date of capture	Trap location by zone	Sex	Age	Collar colour	Frequency (MHZ)	Eartags Colour	Eartags Left	Eartags Right
1689	27-ii-79	4	F	A	red/green stripe	151.293	yellow	186 B	187 B
1690	30-i-79	4	F	A	red/yellow stripe	151.312	white	76 A	77 A
1691	22-ii-79	4	F	A	green/white stripe	151.320	yellow	180 B	181 B
1692	2-ii-79	4	F	A	white	151.340	white	85 A	87 A
1693[d]	27-ii-79	4	F	A	red/blue block	151.370	yellow	190 B	191 B
1694	30-i-79	4	F	C	red/yellow block	151.388	white	78 A	79 A
1695	2-ii-79	4	F	C	purple/white block	151.427	white	96 A	97 A
1696	8-ii-80	8	M	A	blue	151.345	red	118 B	119 B
1697	13-ii-80	G	M	A	blue/yellow block	151.437	red/blue	120 B	118 B

[a]The collar on this elk was originally placed on elk 1680 and recovered in the field.

[b]Collar not functioning March 6, 1980 and subsequently.

[c]Killed during 1979 hunting season.

[d]Died during winter 1979-1980.

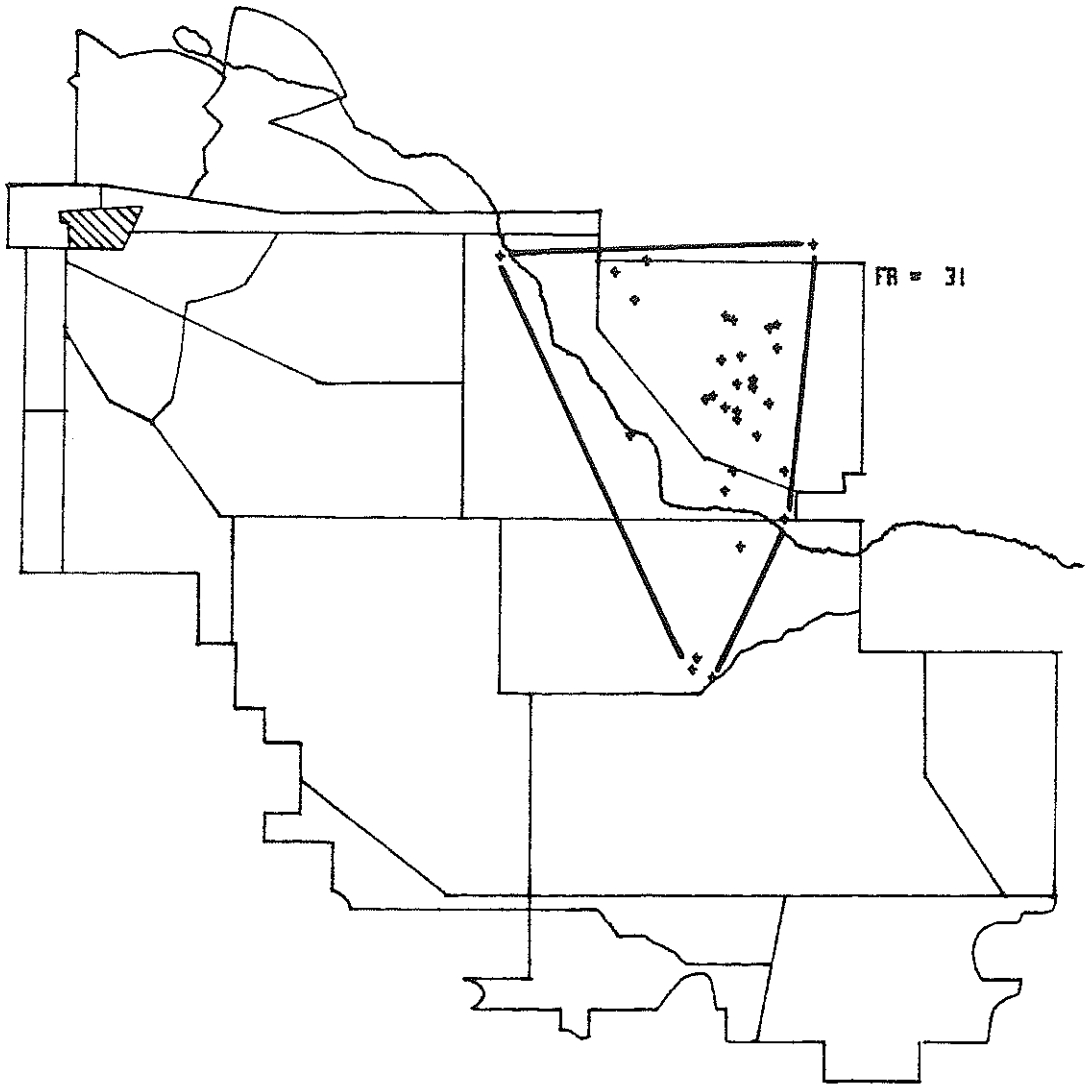
APPENDIX B

Number of relocations for instrumented elk on the Shilo Military Reserve, 1979-1980
(x = collar recovered, - = animal not transmitting, blank = no relocations attempted)

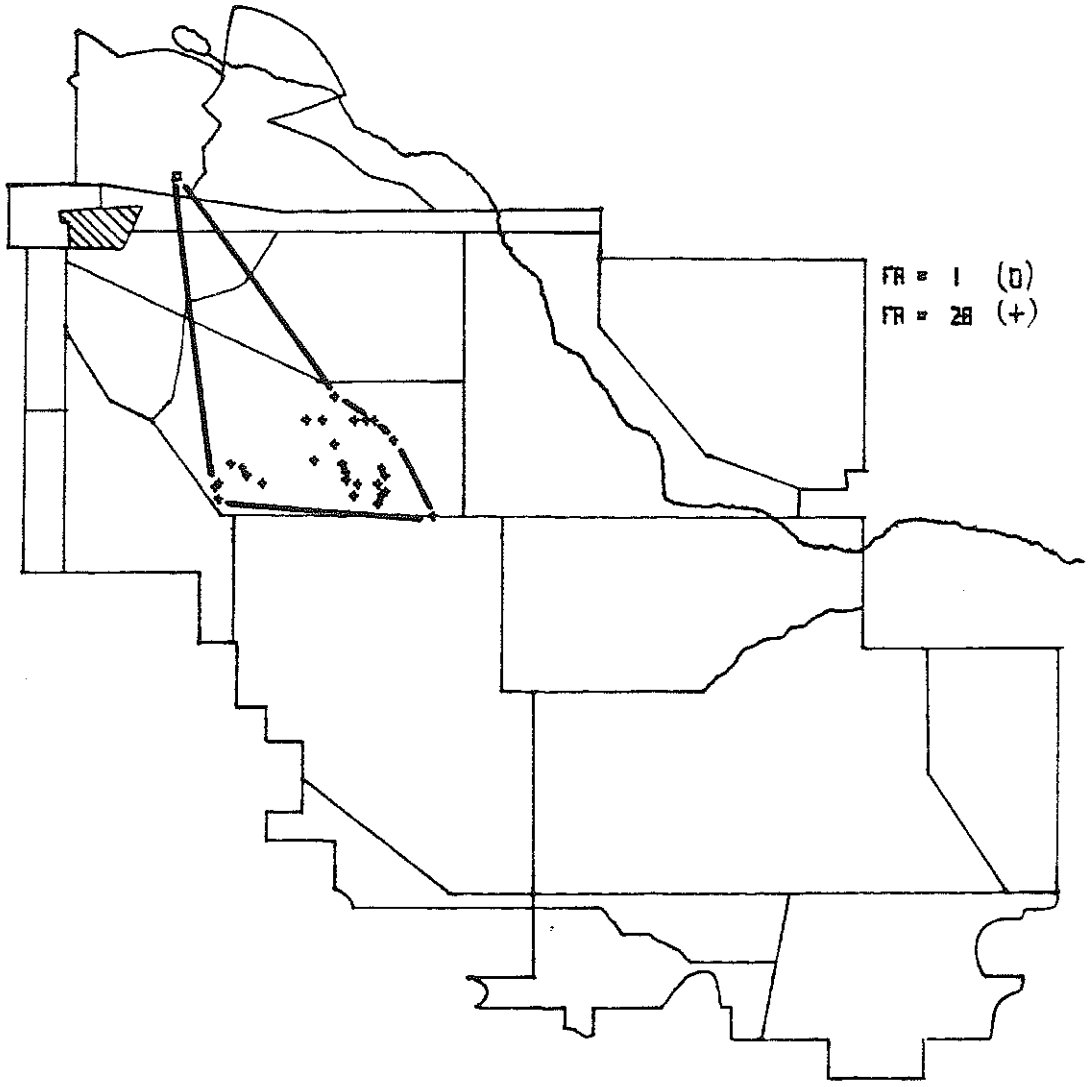
	January 1979	February 1979	March 1979	April 1979	May 1979	June 1979	July 1979	August 1979	September 1979	October 1979	November 1979	December 1979	January 1980	February 1980	March 1980	April 1980	May 1980	June 1980	July 1980	August 1980	September 1980	October 1980	November 1980	December 1980	Total
680														1	0	0	0	0	0	0	3	14			18
1099			4	0	2	8	5	3	1	0	1	1	0	0	0	0	5	3	5	13	31	8			90
1633															1	0	3	2	3	3	17	14			43
1641		1	2	0	3	8	5	1	0	0	1	2	0	0	0	0	1	6	5	2	21	7			65
1669			2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			2
1676		2	4	0	2	5	1	0	0	1	2	4	0	4	0	0	0	0	0	0	0	0			25
1677	0	0	0	0	1	4	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0			9
1678	1	1	2	0	2	6	5	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-			17
1679		1	2	0	4	0	1	1	0	0	1	1	0	0	0	0	0	0	0	1	7	6			25
1680		2	3	0	3	2	3	x																	13
1681		1	3	0	1	0	0	0	0	0	x														5
1682		2	3	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			14
1683		1	1	0	4	6	3	2	1	0	0	1	0	0	0	0	0	1	1	3	24	6			54
1684		1	2	0	4	0	0	1	0	0	0	2	0	0	0	0	0	1	0	0	11	3			25
1685	1	1	3	0	10	8	8	5	0	0	0	2	0	0	0	0	2	0	1	0	6	3			50
1686		2	1	0	0	0	3	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	x	-	8
1687		1	2	0	8	7	6	1	0	0	0	1	0	0	0	0	0	3	6	0	24	8			67
1688		2	1	1	5	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			16
1689		1	1	0	2	2	2	0	1	0	0	1	0	0	0	0	0	0	0	0	13	3			26
1690	1	1	2	0	1	1	1	0	1	1	1	1	0	0	0	0	0	0	1	1	4	6			23
1691		1	0	0	2	4	1	4	1	0	0	1	0	0	0	0	0	0	1	0	2	7			24
1692		2	1	0	3	4	3	2	0	0	0	2	0	0	0	0	0	0	2	1	16	7			43
1693		1	2	0	5	9	4	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0			25
1694	1	1	3	0	4	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0			11
1695		2	2	0	1	4	1	0	0	0	0	1	0	0	0	0	2	3	0	2	22	5			45
1696														1	0	0	4	0	0	0	0	0			5
1697														1	0	0	1	1	1	0	3	x			7

APPENDIX C

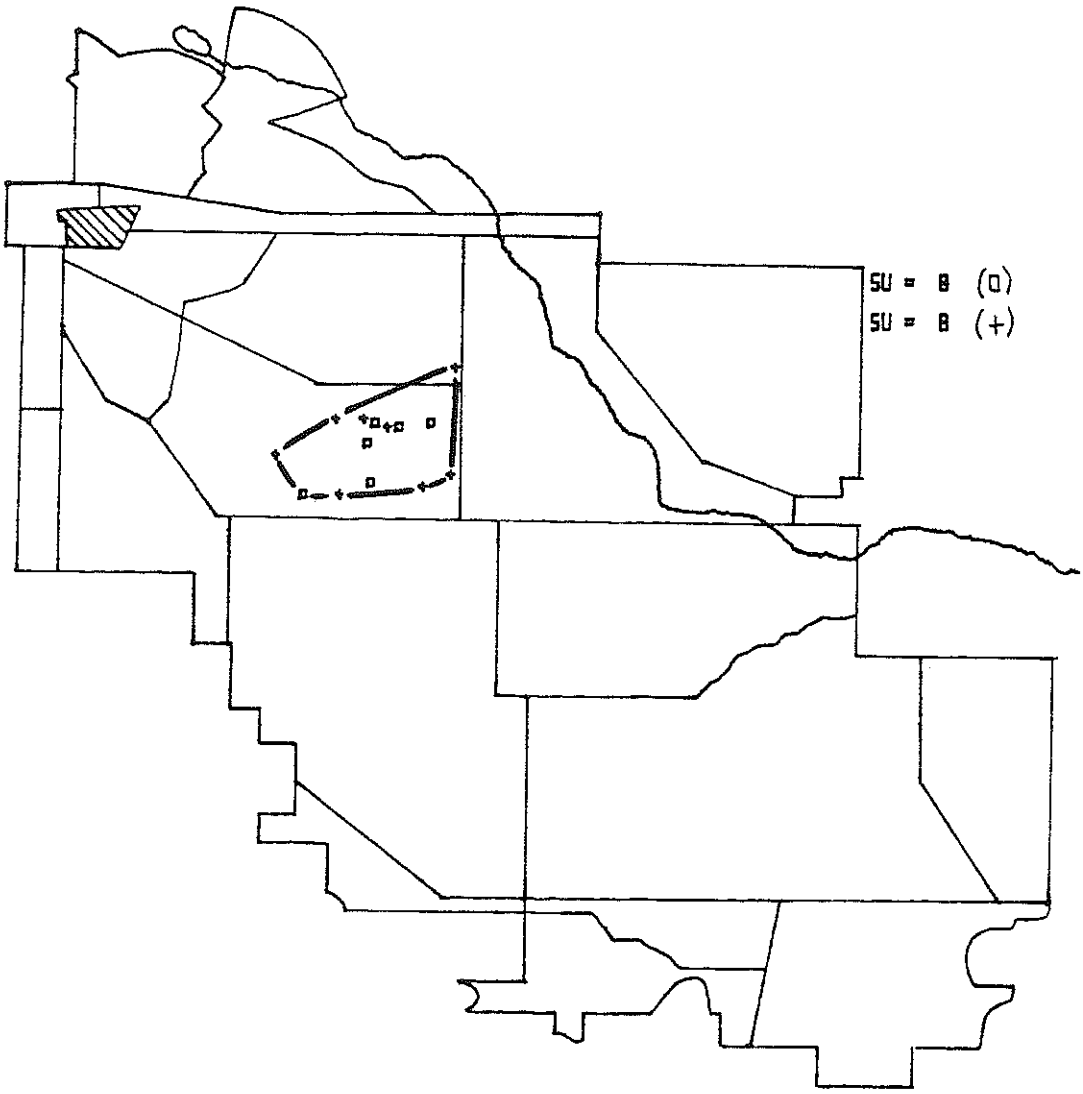
Seasonal range maps



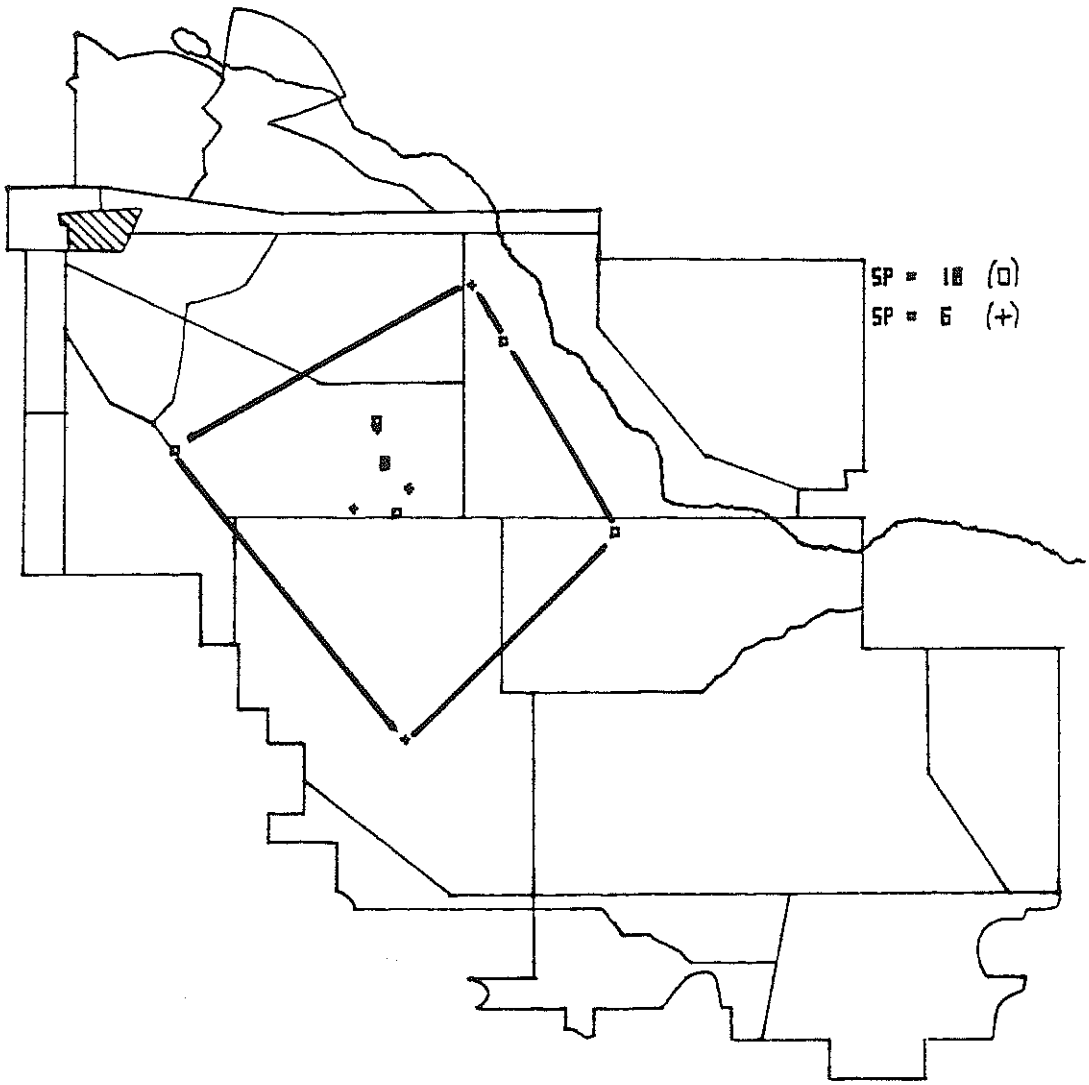
1980 fall range of elk 1633



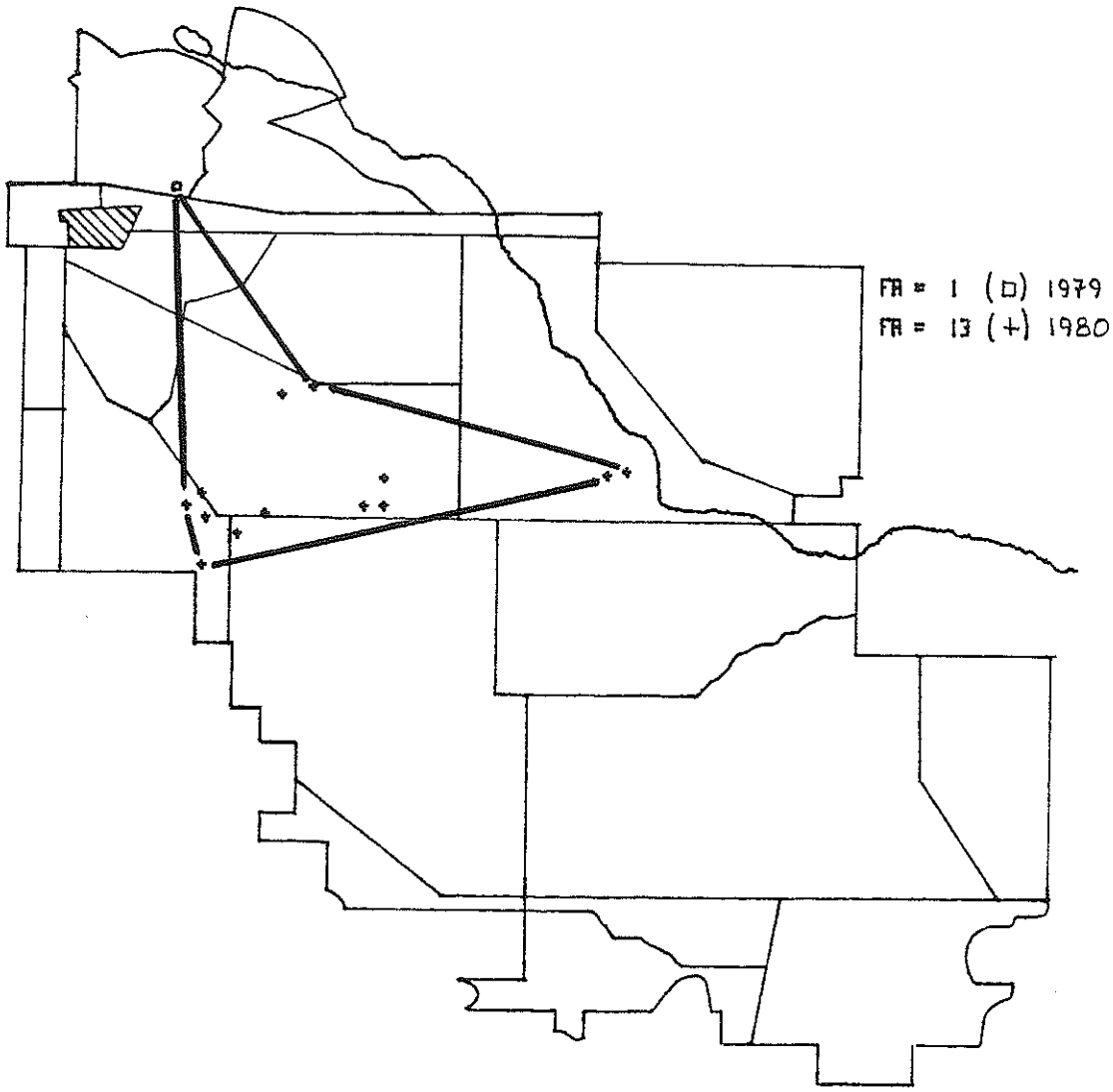
1979 and 1980 fall range of elk 1641



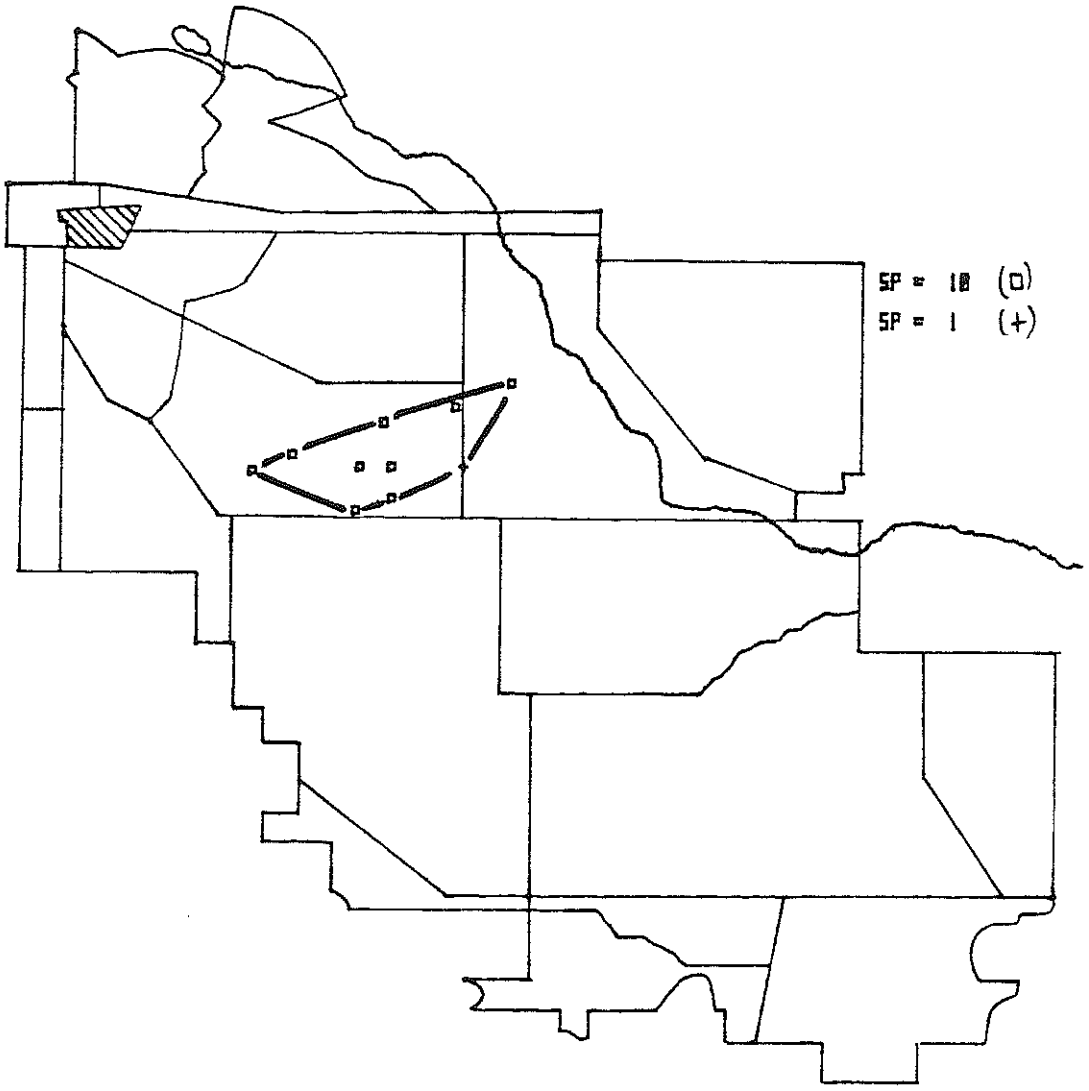
1979 and 1980 summer range of elk 1641



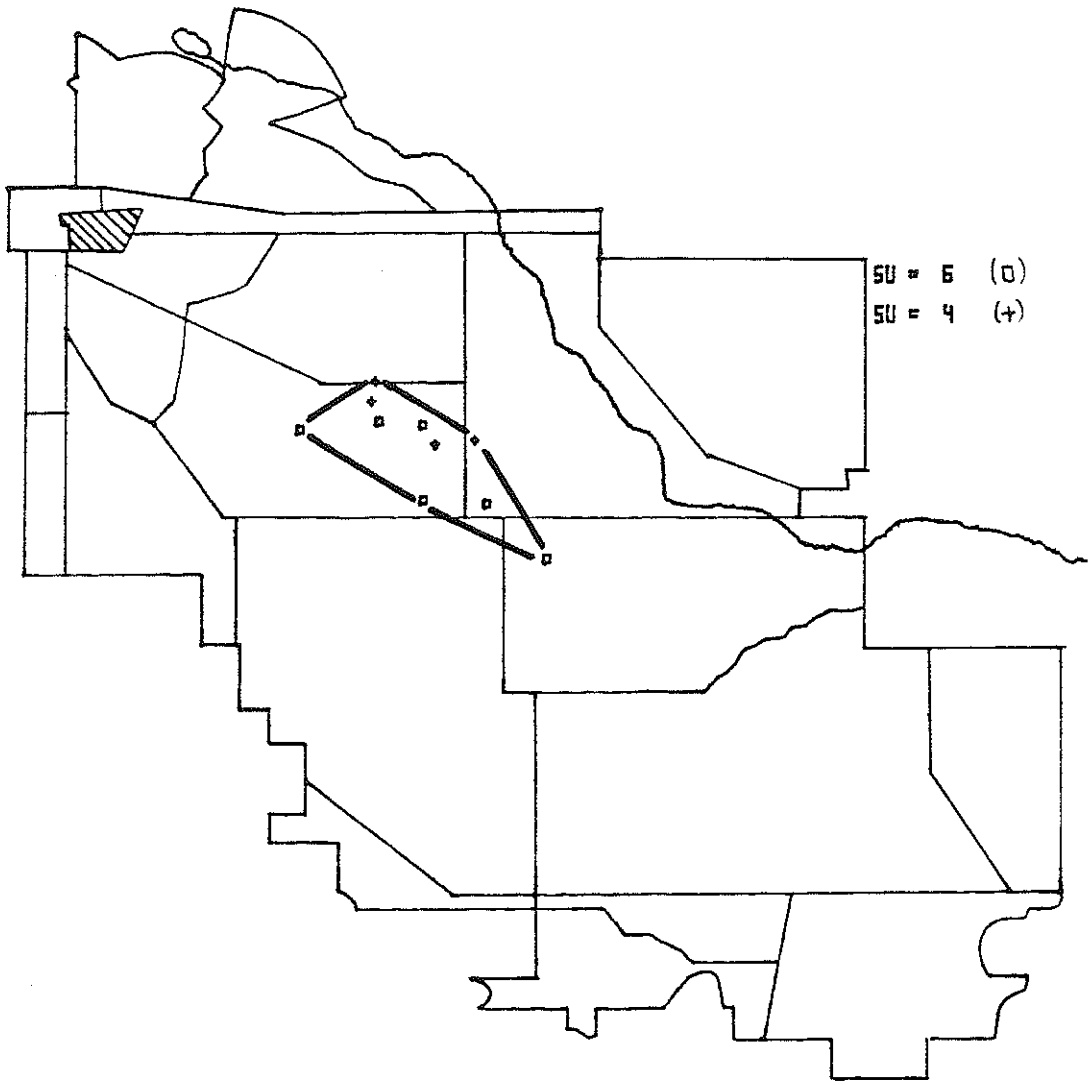
1979 and 1980 spring range of elk 1641



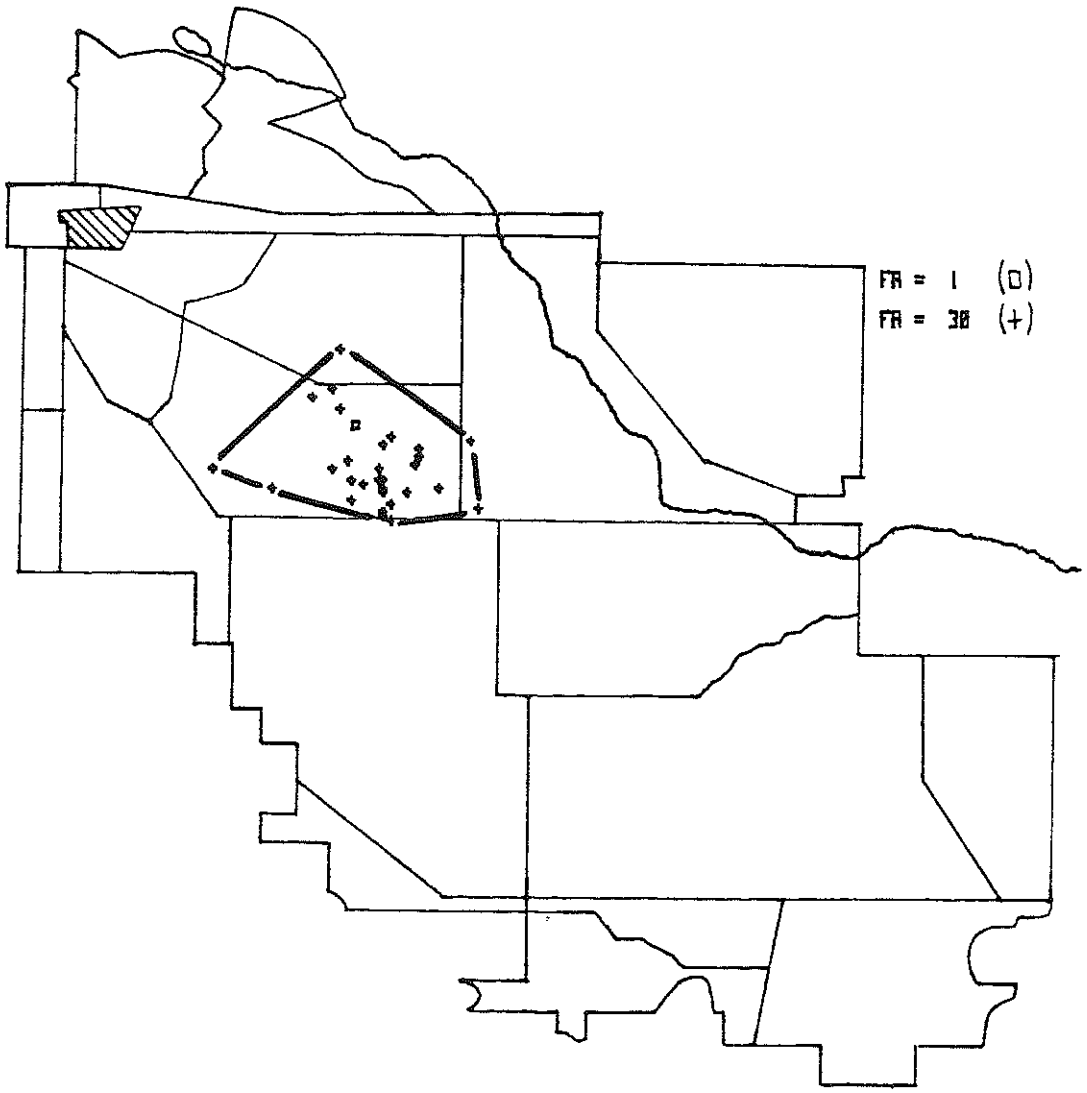
1979 and 1980 fall range of elk 1679



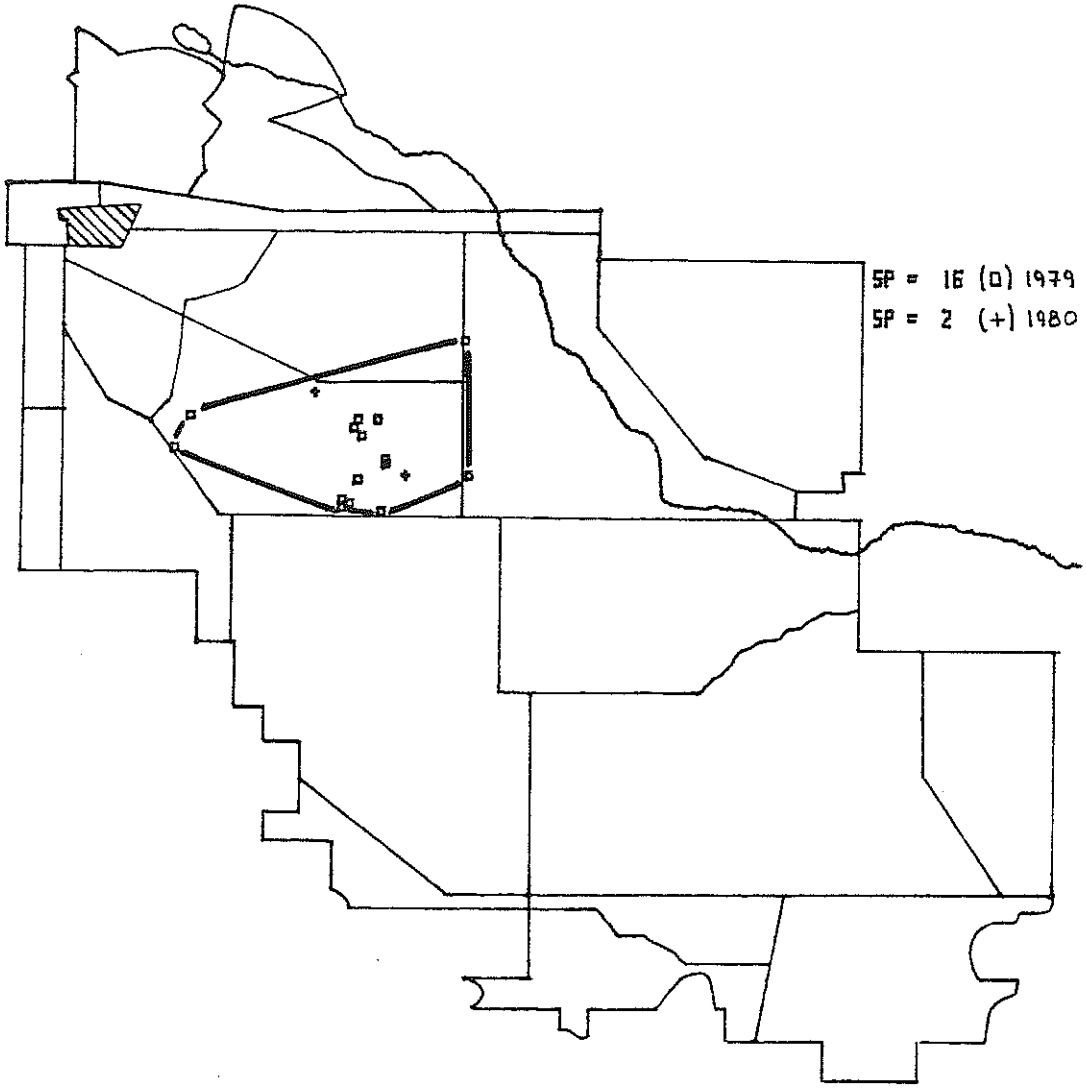
1979 and 1980 spring range of elk 1683



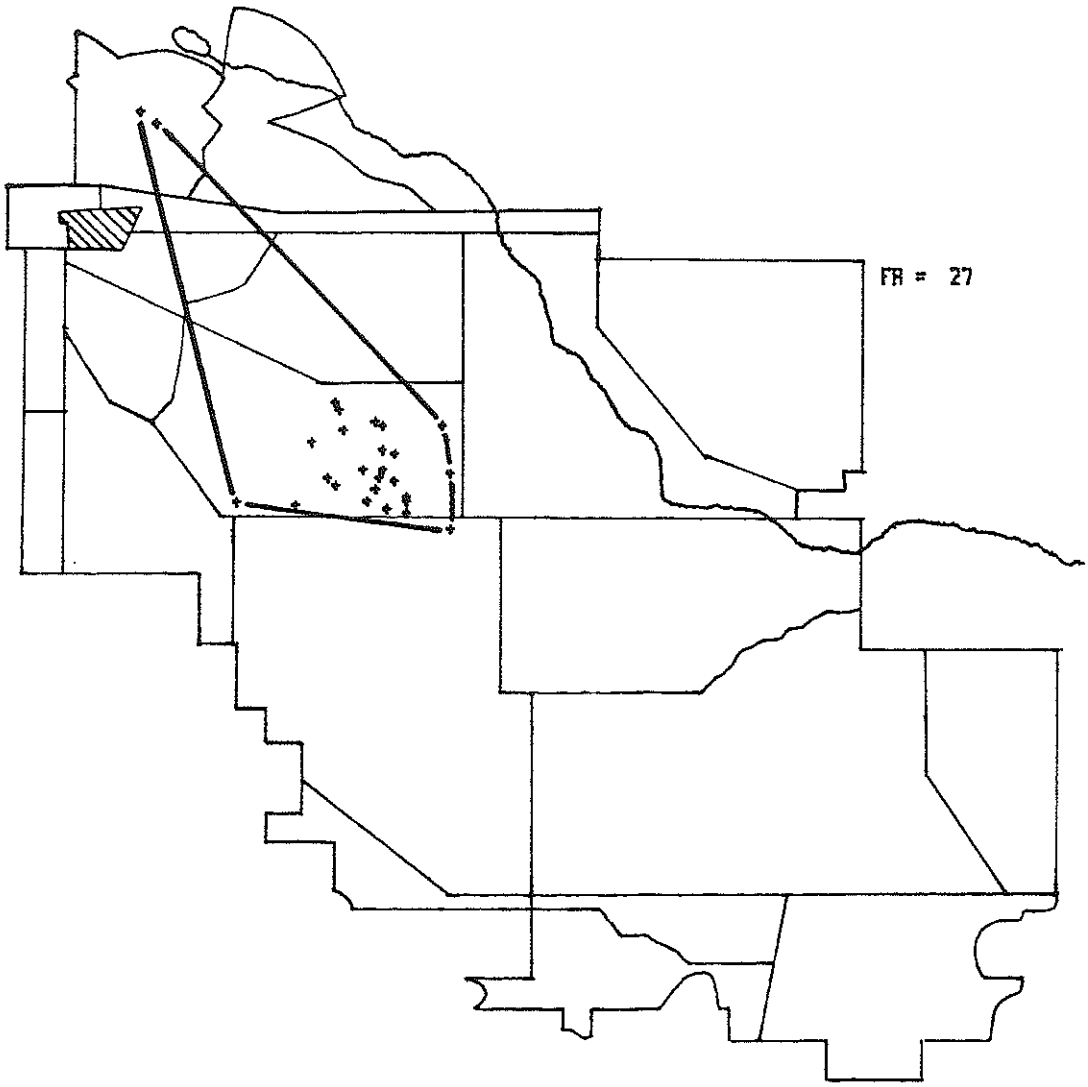
1979 and 1980 summer range of elk 1683



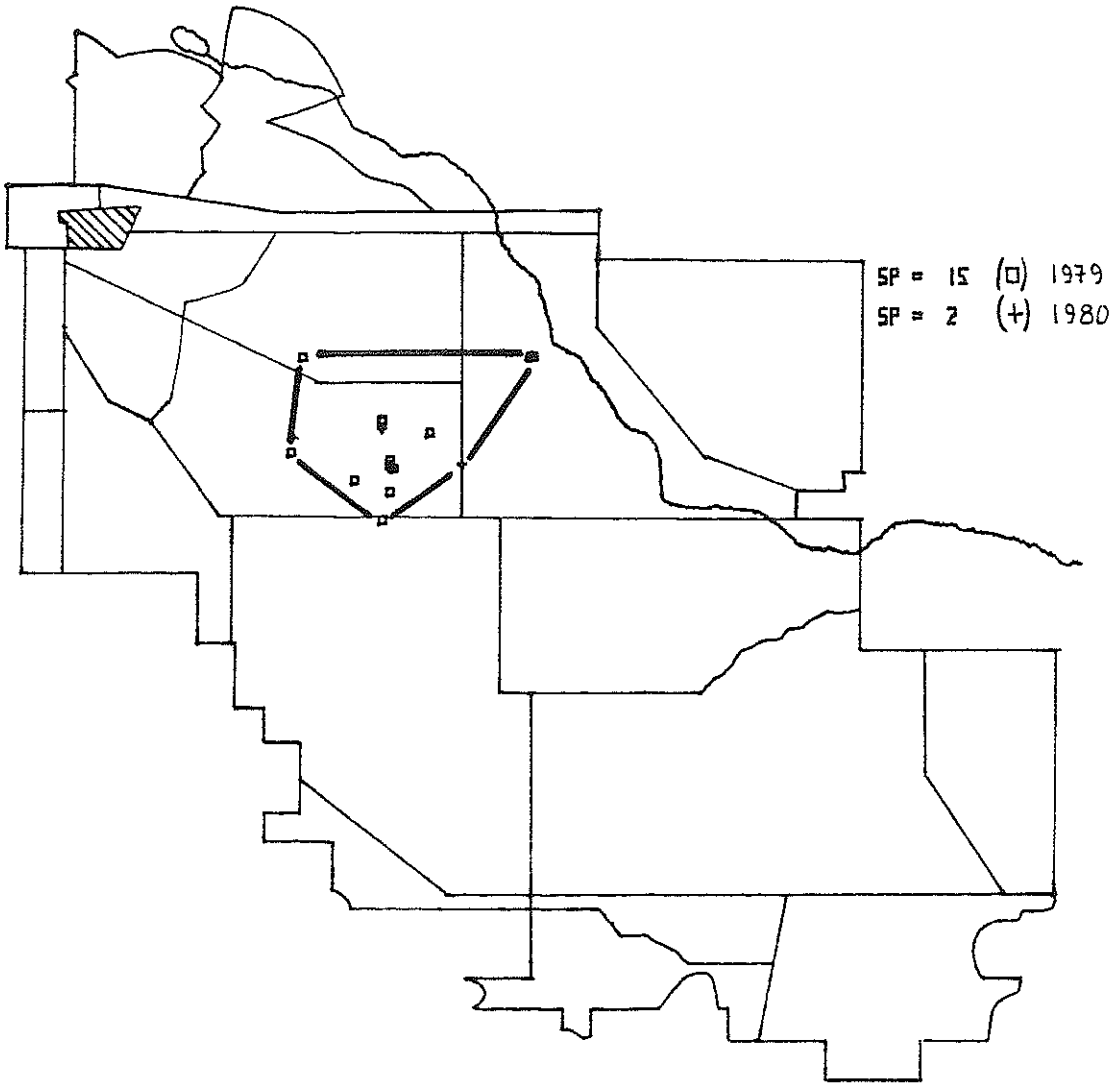
1979 and 1980 fall range of elk 1683



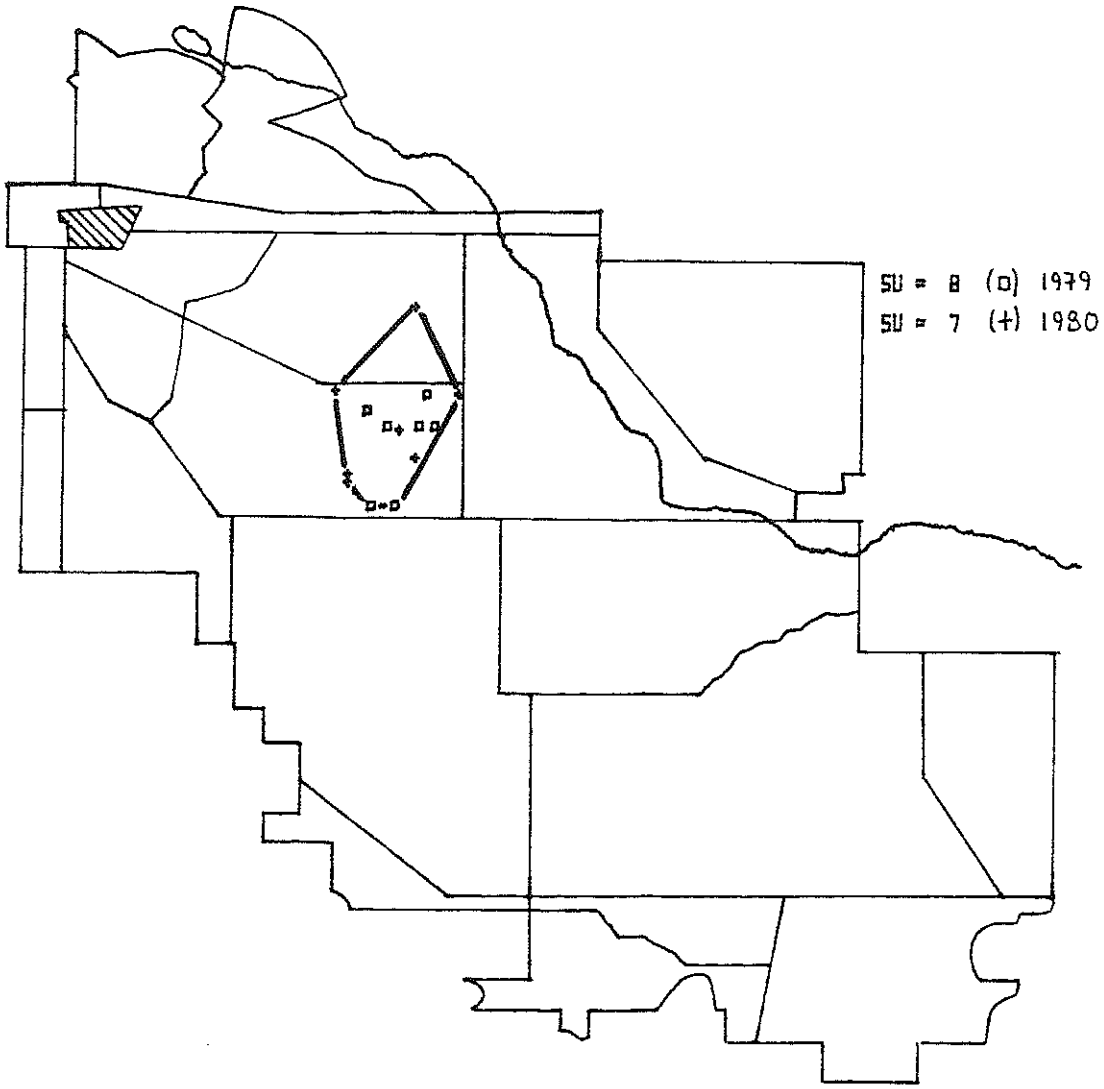
1979 and 1980 spring range of elk 1685



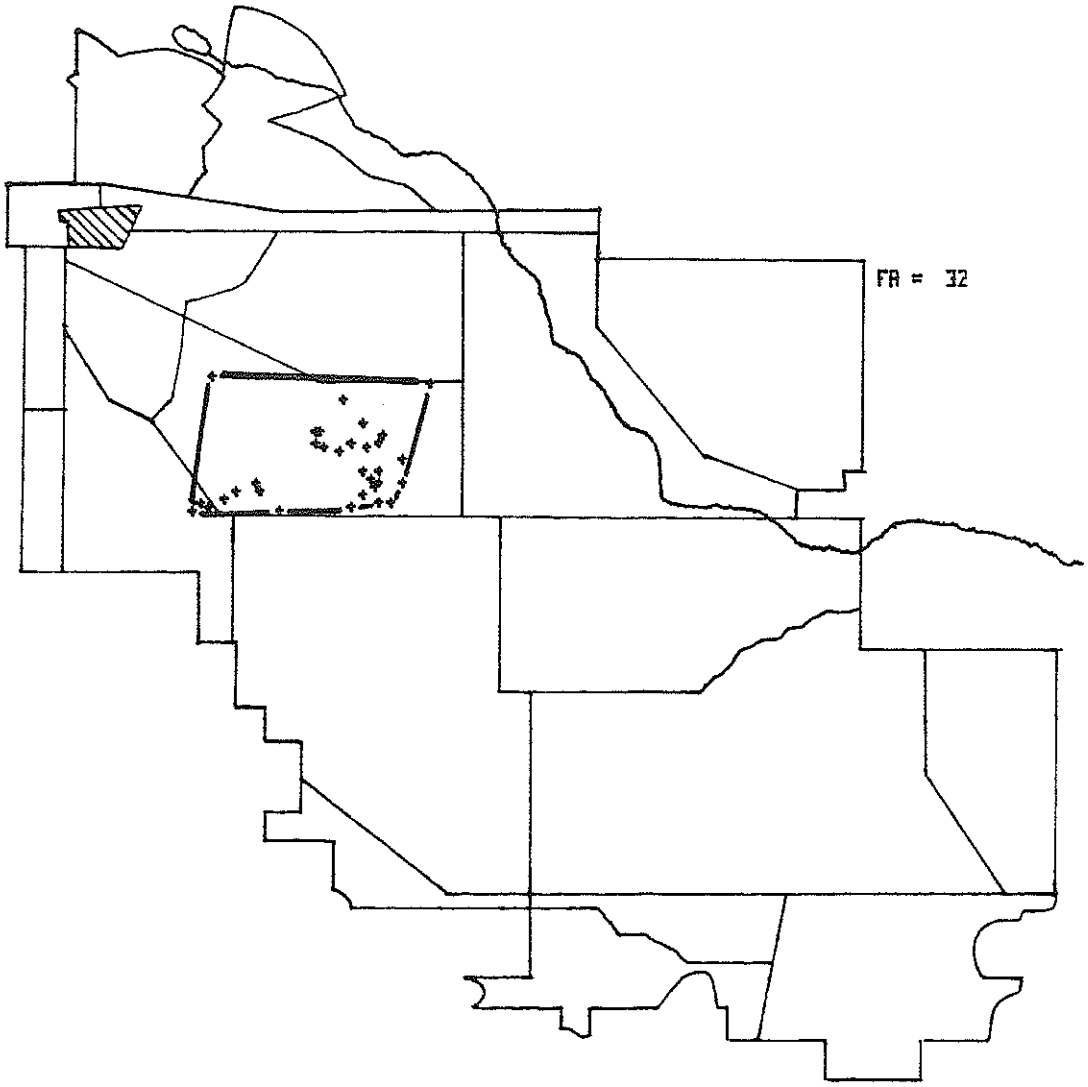
1980 fall range of elk 1695



1979 and 1980 spring range of elk 1687



1979 and 1980 summer range of elk 1687



1980 fall range of elk 1687